Sci. Biol.

12/10/59


# SCIENCE

11 December 1959

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE


519 S5

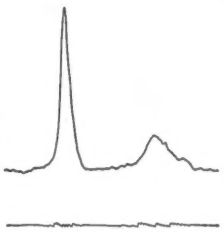
6 DEC 14 1959
Cont. Copy 2

# PAPER ELECTROPHORESIS

*... now more useful than ever in analyzing biological materials*

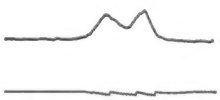
Thousands of laboratories routinely run serum proteins by paper electrophoresis as an aid in diagnosing hepatitis, agammaglobulinemia, the myelomas and a variety of related pathologies. Now this simple diagnostic aid is being used to separate other serum components of medical significance.

**LIPOPROTEINS**



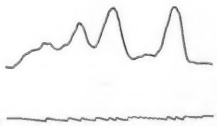
The relationship between these fat-protein molecules and atherosclerosis, liver diseases, diabetes and obesity has made lipoproteins an important field of research.

**HEMOGLOBINS**



Sickle cell anemia is revealed by the presence on the paper strip of both normal and sickle-cell hemoglobins.

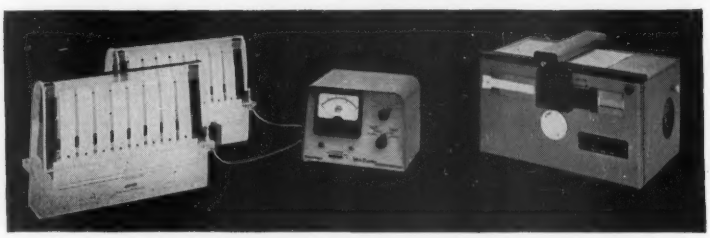
**GLYCOPROTEINS**



Changes in glycoproteins are often greater and more specific than changes in serum proteins. Indications of glycoprotein correlations are reported in studies of cancer, collagen diseases, acute and chronic infections and tuberculosis.

These new analyses can be performed on the same Model R equipment chosen by most laboratories using paper electrophoresis. The equipment is easy for technicians to use, gives uniform, reproducible results, and lends itself readily to different analyses, dyes and techniques. For more information, please return coupon below.

**Beckman®** / **Spinco Division**
*Beckman Instruments, Inc.*



*Beckman/Spinco Model R System: electrophoresis cell, power supply and scanner*

5-52

*To:* Spinco Division, Beckman Instruments, Inc., Stanford Industrial Park, Palo Alto 5, California

☐ Please send me information on the clinical significance of paper electrophoresis, and a description of the equipment required.

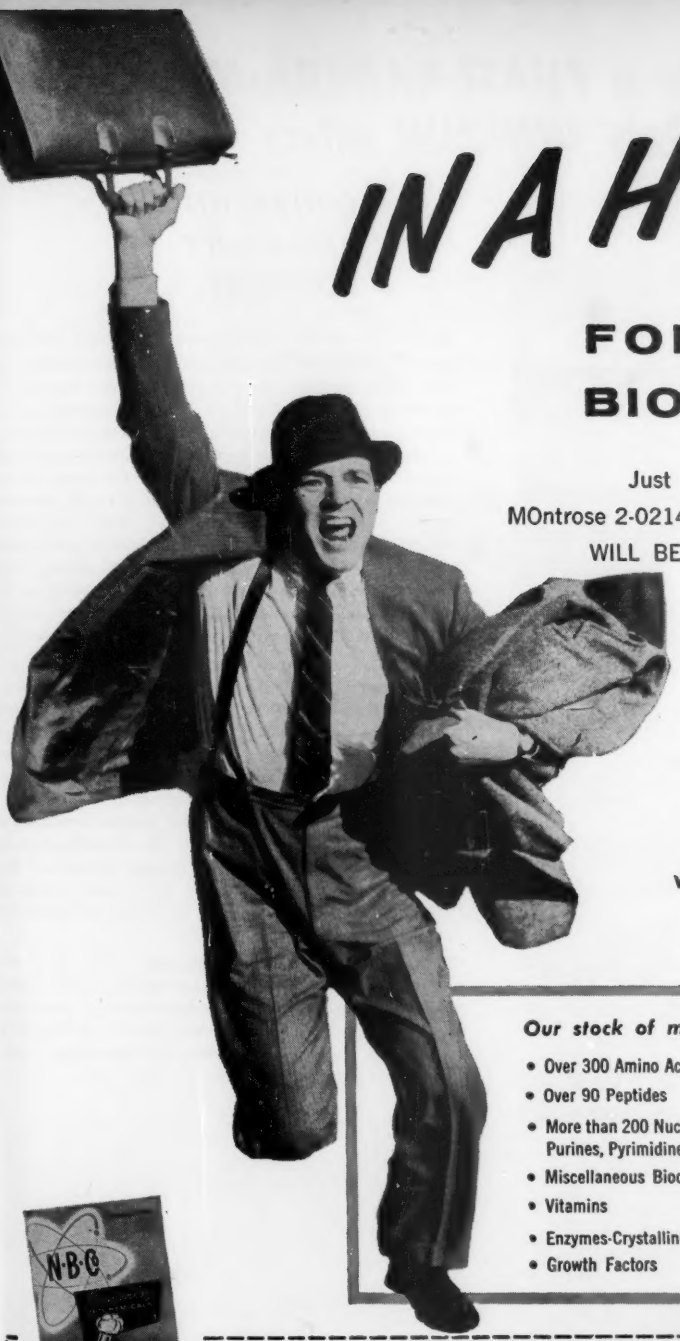
☐ I own a Model R System and would like additional information on recently-reported methods.

NAME _____

INSTITUTION _____

ADDRESS _____

_____



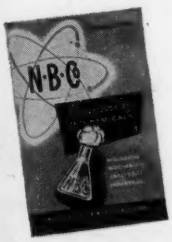
# IN A HURRY!

## FOR RESEARCH BIOCHEMICALS?

Just phone our EMERGENCY number . . . MOntrose 2-0214, Cleveland, Ohio . . . and your ORDER WILL BE SHIPPED WITHIN ONE HOUR! Even our normal service is fast . . . every order shipped within 8 hours of receipt! And of course, every NBCo biochemical is the highest quality available commercially . . . at the lowest possible price! Yes, you get the BEST for LESS when you buy from NBCo . . . and you get DELIVERY when you NEED it! Why not call us the next time you need ANY biochemicals?

***Our stock of more than 2,500 items includes:***

- Over 300 Amino Acids
- Over 90 Peptides
- More than 200 Nucleoproteins, Purines, Pyrimidines
- Miscellaneous Biochemicals
- Vitamins
- Enzymes-Crystalline, Purified
- Growth Factors
- Steroid Hormones
- Biological Salt Mixtures
- Biological Test Materials
- Carbohydrates
- Purified Proteins
- Fatty Acids
- Antibiotics
- Alkaloids
- Glandular Substances




**OUR NEW OCT. 1959 CATALOG**
containing more than 2,500 items is now ready. Fill out coupon below and mail today for your free copy.

Name _____

Firm or Organization _____

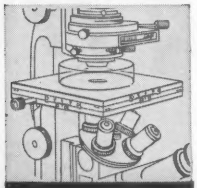
Address _____

City _____ Zone _____ State _____

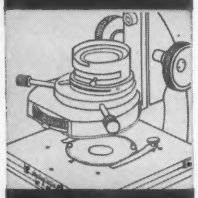
**NUTRITIONAL BIOCHEMICALS CORPORATION**
21012 MILES AVENUE
CLEVELAND 28, OHIO


SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C. Second-class postage paid at Washington, D.C., and additional mailing office. Annual subscriptions: $8.50; foreign postage, $1.50; Canadian postage, 75¢.

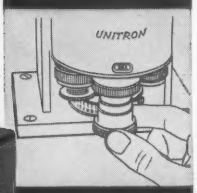
# *In a PHASE-CAMERA-MICROSCOPE Only UNITRON offers all three:*



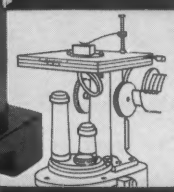
Graduated Mechanical Stage



Focusable Turret Condenser




Photographic Eyepiece Turret



Macro Accessories

✓ **CONVENIENCE**
✓ **VERSATILITY**
✓ **ECONOMY**

UNITRON'S unique Phase-Camera-Microscope will assure you a **CONVENIENCE** of operation impossible to duplicate with a conventional microscope stand. For example, a specimen consisting of a tissue culture or aqueous solution may be examined in the very petri dish in which it has been prepared. Merely place the dish on the microscope stage; examine the contents visually, project the image on the viewing screen, or photograph — all in rapid sequence and at magnifications up to 2000X. With the inverted design, there is no need to contend with slipping cover glasses or evaporating fluids. Using the phase optics, you dispense with messy chemical staining. Aided by the self-contained illumination system and built-in cameras, you eliminate troublesome problems of alignment and vibration.

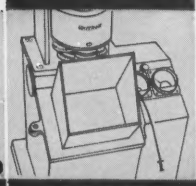
UNITRON'S Phase-Camera-Microscope, optically equipped for Bright and Dark Phase Contrast, bright and dark field, and polarized light, offers the microscopist a working tool of unmatched **VERSATILITY.** The overhead turret phase condenser is centerable, divisible, and provides long working distances sufficient even for micro-manipulation. Provision is included for four different cameras — 3¼" x 4¼", 35mm., Polaroid, and motion picture. Available at extra cost are macro accessories for magnifications as low as 5X and accessories for opaque specimens. This UNITRON model meets not only your urgent needs of today — its versatility is your assurance of continued usefulness in the future.

UNITRON'S Phase-Camera-Microscope is the ideal all-purpose instrument for visual examination, viewing, and photo-recording. Completely equipped with an impressive array of optics, its cost is actually lower than that of a conventional phase stand, camera and illuminator — true **ECONOMY** for any laboratory.

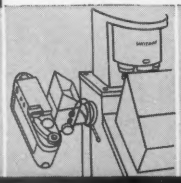
8 Phase Contrast Objectives



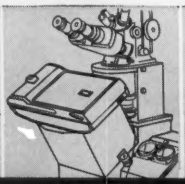
Visual Eyepieces | 4 Photographic Eyepieces, Filters.



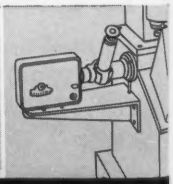
Standard 3¼" x 4¼" Camera



Accessory 35mm. Camera



Accessory 3¼" x 4¼" Polaroid Land Camera



Accessory Motion Picture Camera

**UNITRON'S Phase-Camera-Microscope Model BU-13** as described including binocular body; 8 phase objectives 10X, 20X, 40X, 100X oil, in both bright and dark contrast; paired visual eyepieces R5X, P10X, Ke15X; focusing telescope; four photographic eyepieces 10X, 15X, 20X, Micrometer; phase condenser; filters; polarizing accessories; special glassware, etc.

Monocular Model U-13

**FREE 10-DAY TRIAL**

**$1580**
FOB Boston
**$1390**

**UNITRON**
INSTRUMENT DIVISION OF UNITED SCIENTIFIC CO.
204-206 MILK STREET • BOSTON 9, MASSACHUSETTS

Please rush UNITRON's Microscope Catalog 4X2

Name_____
Company_____
Address_____
City_____ State_____

***THE TREND IS TO UNITRON***

11 December 1959, Volume 130, Number 3389

# SCIENCE

**Editorial** Scholars in Spite of Ourselves ..... 1627

**Articles** Animal Domestication in the Prehistoric Near East: *C. A. Reed* ..... 1629
The origins and history of domestication are beginning to emerge from archeological excavations

Basic Research at State Stations: *H. C. Knoblauch* ..... 1639
Twenty-two percent of federal-grant payments to state agricultural experiment stations support basic science.

**Science in the News** Antarctic Treaty Signed by IGY Nations; Minneapolis Newsman and *Fortune* Editor Win Science Writing Awards; United States and Soviet Union Sign Exchange Pact 1641

**Book Reviews** A. Inkeles and Raymond A. Bauer, *The Soviet Citizen,* reviewed by *W. Schramm;* other reviews ..... 1648

**Reports** Blood Flow Rates by Nuclear Magnetic Resonance Measurements: *J. R. Singer* ..... 1652

Stimulation of Amino Acid Transport in Isolated Diaphragm by Growth Hormone Added in vitro: *J. L. Kostyo, J. Hotchkiss, E. Knobil* ..... 1653

Stimulation of *Striga asiatica* (Witchweed) Seed Germination by 6-Substituted Purines: *A. D. Worsham, D. E. Moreland, G. C. Klingman* ..... 1654

New Permian Insects Discovered in Kansas and Oklahoma: *P. Tasch* and *J. R. Zimmerman* ..... 1656

All-Female Strains of the Teleost Fishes of the Genus *Poeciliopsis*: *R. R. Miller* and *R. J. Schultz* ..... 1656

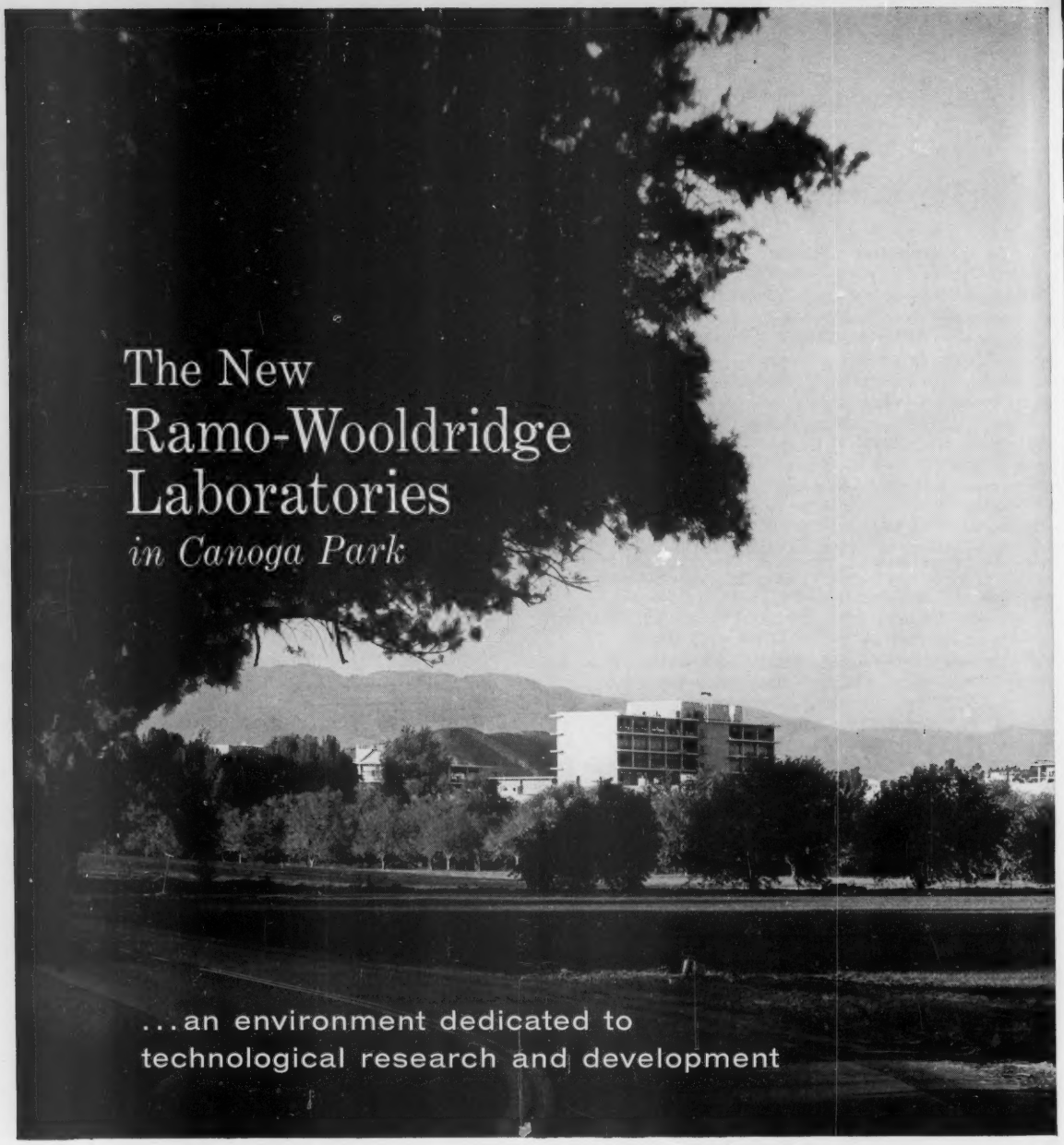
Wave-Riding Dolphins: *W. D. Hayes; P. F. Scholander* ..... 1657

Carbon Isotope Fractionation in Bacterial Production of Methane: *W. D. Rosenfeld* and *S. R. Silverman* ..... 1658

**Departments** Letters ..... 1622

Glucuronic Acid Research; Forthcoming Events; New Products ..... 1660

**Cover** Typical midsummer storm over the Gulf of Mexico, from Madeira Beach (St. Petersburg, Fla.), about 10:00 P.M., 23 July 1959. This was one of five separate storm systems parading northward through the Gulf. This time exposure (approximately 15 seconds), made with a Rolleiflex (2¼ inch square), includes four or five separate flashes, only the last of which was "grounded" into the water. [W. R. Stewart]




The new Ramo-Wooldridge Laboratories in Canoga Park, California, will provide an excellent environment for scientists and engineers engaged in technological research and development. Because of the high degree of scientific and engineering effort involved in Ramo-Wooldridge programs, technically trained people are assigned a more dominant role in the management of the organization than is customary.

The ninety-acre landscaped site, with modern buildings grouped around a central mall, contributes to the academic environment necessary for creative work. The new Laboratories will be the West Coast headquarters of Thompson Ramo Wooldridge Inc. as well as house the Ramo-Wooldridge division of TRW.

The Ramo-Wooldridge Laboratories are engaged in the broad fields of electronic systems technology, computers, and data processing. Outstanding opportunities exist for scientists and engineers.

*For specific information on current openings write to Mr. D. L. Pyke.*

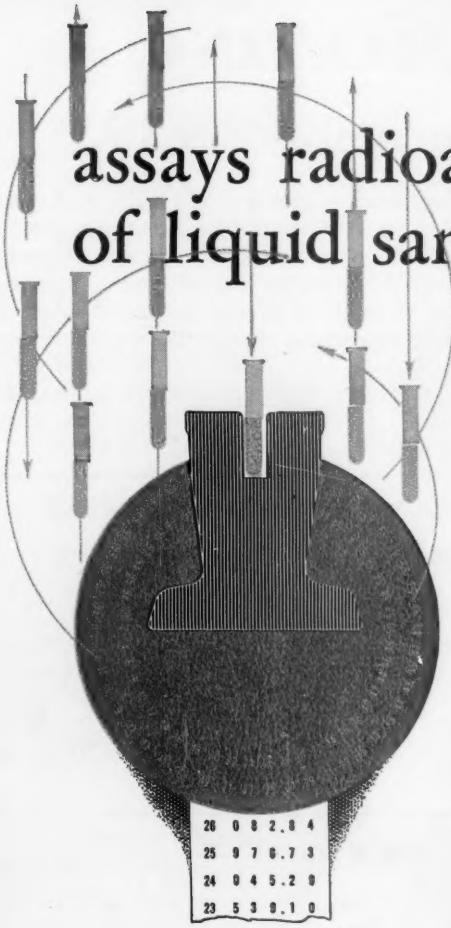
**THE RAMO-WOOLDRIDGE LABORATORIES**

8433 FALLBROOK AVENUE, CANOGA PARK, CALIFORNIA

# assays radioactivity of liquid samples

## *up to a hundred at a time automatically*

### *with accurate count printout*




Here's the way to save hours and days in laboratories handling large numbers of radioactive liquid samples (or smaller numbers. maybe, of low-activity samples which count slowly). Answers the kind of problem that arises, for example, in human blood studies with $Iron^{59}$ or in metabolic studies on test animals.

*Some of its unique features . . .*

**Handles 100 15 cc samples**

**Samples always accessible**

**Uses virtually any well-type scintillation detector**

**Operates with Picker Count-and-Time Printer or Printing Timer**

**Constant background count because samples surround the detector uniformly**

**Modest cost $2,000.00**

*spare hours — save the day — with the*

## PICKER AUTOMATIC WELL COUNTER 2956

This unique instrument is one of the comprehensive Picker family of quality nuclear equipment. The line includes instrumentation for every phase of diagnostic and therapeutic use of radiosotopes.

For particulars, call any Picker District Office —there's probably one near you (see your local 'phone book). Or write Picker X-Ray Corporation, 25 South Broadway, White Plains, New York.

Picker nuclear

PICKER nuclear instruments

# APPLICATION FOR HOTEL RESERVATIONS

## 126th AAAS MEETING

## Chicago, 26-31 December 1959

The four hotels for the AAAS Chicago meeting have established special low rates and have reserved large blocks of rooms at each level within the price ranges quoted. Thus everyone making room reservations for the AAAS meeting is assured substantial savings. Further, all confirmations will state the room rate assigned.

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel reservation in Chicago. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in Chicago and thereby avoid delay and confusion. The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less.

If desired, the hotels will add a cot at $3.00 per night—except that all children under 12 are free. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

### AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

**No sessions in public rooms.* For a list of the headquarters of each participating society and section, see page 228, *Science*, 24 July.

**Rates for Rooms with Bath**

| Hotel | Single | Double Bed | Twin Bed | Suite |
|---|---|---|---|---|
| Morrison | $6.50— 9.00 | $9.00—13.00 | $11.00—15.00 | $30.00 and up |
| Hamilton | 6.50— 9.50 | 9.00—13.00 | 11.00—15.00 | 25.00 and up |
| La Salle | 7.50—10.00 | 10.50—13.00 | 12.50—15.50 | 35.50 and up |
| Sherman | 7.45—12.45 | 11.45—16.45 | 14.45—19.50 | 28.50 and up |
| *Bismark | 6.50—10.00 | 9.00—13.00 | 11.00—15.00 | |

**THIS IS YOUR HOUSING RESERVATION COUPON**

**AAAS Housing Bureau**
**Suite 900**
**134 North La Salle Street**
**Chicago 2, Ill.**

**Date of Application** .....

Please reserve the following accommodations for the 126th Meeting of the AAAS in Chicago, 26-31 Dec., 1959:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

**(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)**

.....

.....

**First Choice Hotel** ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

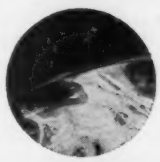
NAME .....
(Individual requesting reservation) (Please print or type)

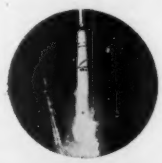
ADDRESS .....
(Street) (City and Zone) (State)

*Mail this now to the Housing Bureau.* Rooms will be assigned and confirmed in order of receipt of reservation.

**Explorer VI is a space laboratory orbiting around the earth with paddles capturing sunlight for power**

The scientific data that will some day enable us to probe successfully to the very fringes of the universe is being recorded and transmitted at this moment by the space laboratory Explorer VI, a satellite now in orbit around the earth ● This project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, will advance man's knowledge of: *The earth and the solar system . . . The magnetic field strengths in space . . . The cosmic ray intensities away from earth . . . and, The micrometeorite density encountered in inter-planetary travel* ● Explorer VI is the most sensitive and unique achievement ever launched into space. The 29" payload, STL designed and instrumented by STL in cooperation with the universities, will remain "vocal" for its anticipated one year life.





How? Because Explorer VI's 132 pounds of electronic components are powered by storage batteries kept charged by the impingement of solar radiation on 8,000 cells in the four sails or paddles equivalent to 12.2 square feet in area ● Many more of the scientific and technological miracles of Explorer VI will be reported to the world as it continues its epic flight. The STL technical staff brings to this space research the same talents which have provided systems engineering and over-all direction since 1954 to the Air Force Missile Programs including Atlas, Thor, Titan, Minuteman, and the Pioneer I space probe.

**Important staff positions in connection with these activities are now available for scientists and engineers with outstanding capabilities in propulsion, electronics, thermodynamics, aerodynamics, structures, astrophysics, computer technology, and other related fields and disciplines.**

***Space Technology Laboratories, Inc.***

*Inquiries and resumes are invited.*

*P. O. Box 95004*
*Los Angeles 45, California*

# Letters

## Origin of Life

The recent review by Miller and Urey [*Science* **130**, 245 (1959)] discounts the pioneering contribution of Calvin *et al.* to our understanding of the origin of organic compounds on the primitive earth. Miller and Urey object to the low yields recorded in 1951 for the conversion of carbon dioxide and water to formaldehyde and formic acid. Perusal of the details published by Calvin reveals, however, one conversion of carbon dioxide to formic acid of 25 percent, which is in excess of Miller's typical total yield of amino acids, natural and unnatural. More relevant, however, is the fact that while highest possible yields may be an appropriate objective in some situations, this goal does not necessarily have meaning in the context under discussion. For life to begin, no more is required conceptually than an infinitesimal pinch of organic stuff of the proper sort and organization; this pinch would need the ability to replicate itself from carbon compounds in the environment and to adapt. By the same reasoning, small proportions of carbon dioxide are adequate as Calvin's inorganic intermediates.

The objections raised to the thermal theory in this same review have already been raised and answered by me (except for some discussion about malic acid which I prefer to reserve until relevant experiments have been completed). With the exception of an incomplete allusion to thermal algae and bacteria, these answers do not appear in the review by Miller and Urey.

Other papers which answer the objections even more fully and have not been cited are Fox, Harada, and Vegotsky, *Experientia* **15**, 81 (1959) and Fox, *Bull. Am. Inst. Biol. Sci.* **9**, 20 (1959). To repeat here briefly an answer to a principal criticism, it is well known that proteins are not readily coagulated if relatively *dry*, and that they are also protected in hot aqueous solution by other substances, notably acidic polymers such as nucleic acids. Temperature and hydration must be specified in such studies. It is moreover possible, by changing these conditions properly, to demonstrate the inevitable formation from synthetic protein-like polymers of microscopic entities in the bacterial range of size and with other properties of bacterial cell membranes [S. W. Fox, K. Harada, J. Kendrick, *Science* **129**, 1221 (1959)].

Once the proper intermediates existed, the first formation of life need not have required as much time as is supposed. Although some organic intermediates may have evolved slowly, there is no basis for excluding the possibility that many biochemical sequences occurred too rapidly for complete thermal decomposition of organic substances to constitute a barrier. Neither is there a basis for decreeing that reactions must have occurred at the surface of the earth rather than in warmer subterranean passages, or for implying that reactions which are demonstrated at 170°C in the laboratory cannot occur more slowly at lower temperatures, or for ignoring the effect of phosphoric acid, which we have shown increases rates of many thermal polymerizations of amino acids. [A. Vegotsky and S. W. Fox, *Federation Proc.* **18**, 343 (1959).] There is also no basis for invoking Abelson's experiments with alanine in water as a direct guide for the behavior of amino acids heated while dry in the absence of oxygen. We, and also Meggy, have shown in this case too that the presence or absence of water greatly alters results; a difference was, furthermore, anticipated on the basis of thermodynamic theory, as indicated in papers from our laboratory and from Meggy's laboratory.

Polyglycine and polyaspartic acid, the latter actually a polyimide, have been produced by dry heat and may be considered well known, as claimed by Miller and Urey. The thermal synthesis of peptides containing all of the 18 common amino acids is the significant advance in this context, however, and was not accomplished before our discovery of the necessary conditions. These conditions, notably excess dicarboxylic amino acids, largely protect 16 otherwise thermolabile amino acids from decomposition and yield relatively colorless protein-like polymers. These reactions have been repeated in other laboratories. Miller and Urey seem to have missed in particular this critical point about the protective effect of the hypohydrous acidic milieu.

As Miller and Urey have acknowledged, amino acids may be produced with each of many forms of energy, including electrical, thermal, and solar energy, from plausible prebiological intermediates. Incidentally, yields of aspartic acid by thermal conversion of ammonium hydrogen malate exceed 40 percent, but the case for thermal pathways can rest alone on relationships to biochemical and evolutionary principles. It seems to me that our present state of ignorance does not permit anyone to maintain that any one or any several syntheses were applicable to the primordial situation. Perhaps the best that one can do at present is to collate experiments in this context and determine which modes are intraconsistent and extraconsistent with other knowledge.

Miller and Urey recognize that a working premise of similarity between prebiological chemistry and biological chemistry provides the precious attribute of testability [S. W. Fox, *J. Chem. Educ.* **34**, 472 (1957)]. They nevertheless seem to prefer, as intermediates for amino acids, aminonitriles, which have no known biological counterpart, to Krebs-cycle acids which are both biological and thermal precursors.

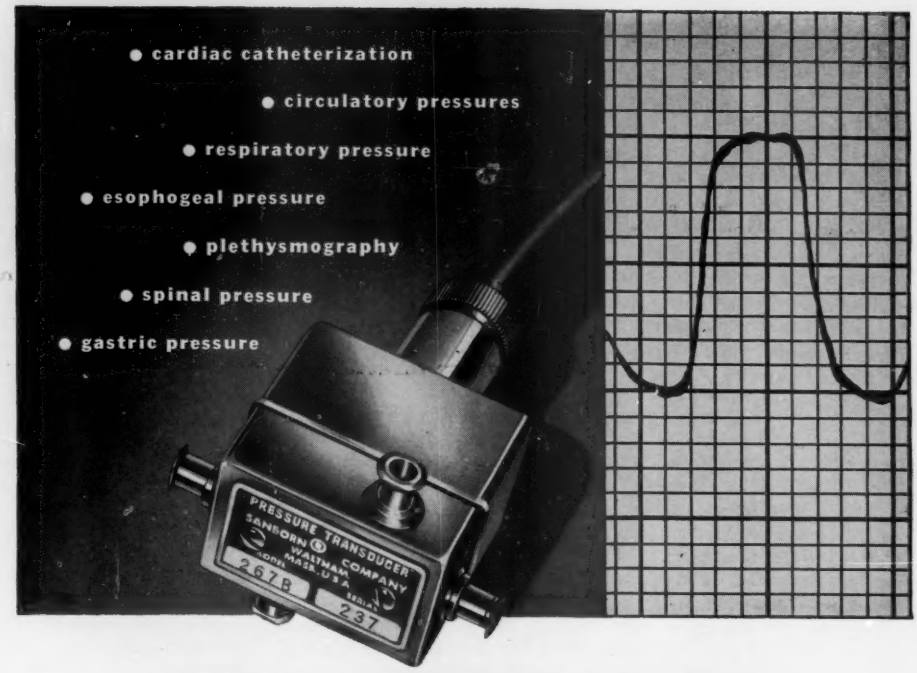
Seemingly logical preconceptions about the difficulties of a thermal mode are outlooks I once shared [*Am. Scientist* **44**, 347 (1956)]. It is nevertheless true that if the conditions are studied closely enough, and if hydration is controlled in a continuum as indicated, there result not only polymers with properties markedly like those of natural proteins but a relatively comprehensive outline suggestive of the origin of biochemical and cellular systems. Although such details may at first glance seem trivial, they might well be critical in the chain of events that have led to our all being here.

SIDNEY W. FOX

*Oceanographic Institute,*
*Florida State University, Tallahassee*

We are very glad to see that Sidney Fox is presenting his own ideas in regard to the problem of the origin of life. However, he misunderstands our attitude in regard to the article which we presented to *Science*. We were not writing a general review article of a summary kind but were definitely expressing our own conclusions in regard to the problem. In this sense it is a biased article since it does express our views, which may not accord with those of other people.

Thus, we do not believe that particles accelerated by cyclotrons or other analogous particles which exist in nature as cosmic rays were important in the origin of life. The amount of energy available, as shown by our Table 1, is very small indeed. It is ineffectively used for chemical processes and has a negligible effect at the present time on the properties of the atmosphere of the earth. We think it also had a negligible effect on the primitive earth, and we intended to say this and believe that our statement is correct.




## *for* SINGLE *and* DIFFERENTIAL PRESSURE MEASUREMENTS, SANBORN TRANSDUCERS *provide*

### CHOICE OF SENSITIVITIES

Sanborn Physiologic Pressure Transducers, in two sensitivity series — 1 cm/mm Hg or 1 cm/0.1 mm Hg — provide models for both differential (difference between two variable pressures) and single-ended (difference between a variable pressure and atmospheric pressure) measurement.

**Compact, Precision Construction**

Durable, non-corrosive Monel construction resists normal saline, alcohol and other standard physiologic and sterilization solutions. Chamber design permits flushing liquid to sweep the entire pressure chamber, removing all bubbles. Standard luer female type connections accept all needle and catheter fittings. Extremely small size (1½" high x 1 9/16" wide x 1" deep) allows transducers to be easily supported by ring stand clamp or similar method for use close to the subject under test.

| | Sensitivity | nominal working range | volume displacement |
|---|---|---|---|
| Model 267 | 1 cm/1 mm Hg | −100 to +400 mm Hg | 0.05 mm³/100 mm Hg |
| Model 268 | 1 cm/0.1 mm Hg | −40 to +40 mm Hg | 0.5 mm³/100 mm Hg |

Complete data on the pressure transducers, as well as compatible amplifying, monitoring and recording instruments, is available in a new 42-page "Biophysical Instrument" catalog. Copies are available on request from Inquiry Director, Waltham, Mass.

**SANBORN COMPANY**

Medical Division • 175 Wyman Street, Waltham 54, Mass.

In the second place, we intended to say that we do not believe that high-temperature processes in the neighborhood of 150°C were important in the origin of life. We also conclude this because of the data given in Table 1. The total heat from volcanoes is very small indeed; it is most ineffectively used for chemical processes, is very sporadic, and is localized on the surface of the earth.

What is needed in the prephotosynthetic time on the earth is a steady source of free energy that permits a primitive type of metabolic process during which organized life could evolve before photosynthesis occurred. We disagree with Fox's statement that only a small amount of material is sufficient. We maintain that a steady source of production of compounds is required, which then go through spontaneous chemical reactions to produce more stable compounds again. A small amount of high temperature produced at one spot on the earth, with many years going by before any additional source of energy is available at that location, can make little contribution to an evolutionary process. Only continuous processes enable metabolic experimentation to go on. Of course, a very small amount of "organic stuff of the proper sort and organization" would suffice, provided it were a living cell, but it is the origin of this which is being discussed, and it should not be assumed.

Aside from these general remarks, we wish to criticize certain points in the arguments of Fox.

Fox has not answered our objections to the thermal theory of the origin of life. The question of the source of the malic acid and urea in his experiments has still not been answered, and much of the theory stands or falls on this point. The stability of proteins with respect to coagulation when dry or in the presence of acidic polymers is not an answer to our criticism. We were discussing the stability of the amino acids contained in the protein, and there is no reason to assume that they would be more stable as dry peptides than as amino acids in solution. In fact, serine and threonine would be less stable. Evidence for instability of amino acids in proteins is given by Abelson's experiments with ancient fossils. Only six out of the 18 amino acids present in the original proteins of the sea shell remained, the others having decomposed.

We are surprised that Fox does not accept the fact that most organic compounds are decomposed by long heating. His doubts on this point can, of course, be settled by his conducting experiments on the thermal decomposition of amino acids and other compounds under various "protective" conditions. We do not understand how regions of high temperature (~150°C) can be maintained for appropriate periods of time to produce his polymerization, with the material being expelled after reaction into appropriate lower temperatures. Where does this occur on the earth now? Why should such circumstances have occurred in the past?

We think that the use of such terms as *proteinoid* and *protein-like* is unfortunate. The polypeptides synthesized by Fox are essentially random, except for the end groups. Fox has not shown that these polypeptides have *any* biological activity and has certainly not shown that they have enzymatic activity, which is the activity that is pertinent to the origin of life. The use of the terms *cell-like* and *cell-like membrane* [S. W. Fox *et al.*, *Science* **129**, 1221 (1959)] is also unfortunate. The formation of round particles in the micron range by heating and then cooling a solution of polypeptide and sodium chloride does not justify calling them "cell-like." Naturally there is a boundary between the particle and the solution, but is this a membrane? It is well known that biological membranes are lipid in character. Fox added no lipids to his polypeptide solution, so the particles can hardly have a "cell-like membrane." Also, biological membranes are not inert casings, but they actively transport ions and organic compounds and allow the entry of only a limited number of specific organic compounds.

If, as Fox states, the case for thermal pathways can "rest alone on relationships to biochemical and evolutionary principles," we think that this case will collapse. A scientific theory rests on experiment, and not on crude analogies to accepted theories dealing with other types of processes.

When we spoke of similarity between prebiological and biological chemistry, we meant the similarity of the gross aspects and not of the detailed processes. Were the first organisms made up of proteins, nucleic acids, sugars and lipids, or were other types of compounds used in place of these? It would be convenient for the investigator if the primitive pathways followed the present ones, but surely this is not necessary. If there are different pathways for the synthesis of a certain compound in different organisms, how do we pick the more primitive pathway? If we choose the pathway of the more primitive organism, then why should not even more primitive organisms have used pathways different from these? And certainly one would expect that the chemical reactions which occurred before enzymes were present might have been different. In any case, Fox's pathways do not follow present biochemical pathways particularly closely, in spite of his claims.

Finally, we do not agree that Fox has synthesized polymers "markedly like those of natural proteins." His "relatively comprehensive outline suggestive of the origin of biochemical and cellular systems" is a "theory" that is not testable in its present form. It says little more than the statement that life arose from a rare event by chance.

STANLEY L. MILLER
*Department of Biochemistry, College of Physicians and Surgeons, Columbia University, New York, New York*
HAROLD C. UREY
*School of Science and Engineering, University of California, La Jolla*

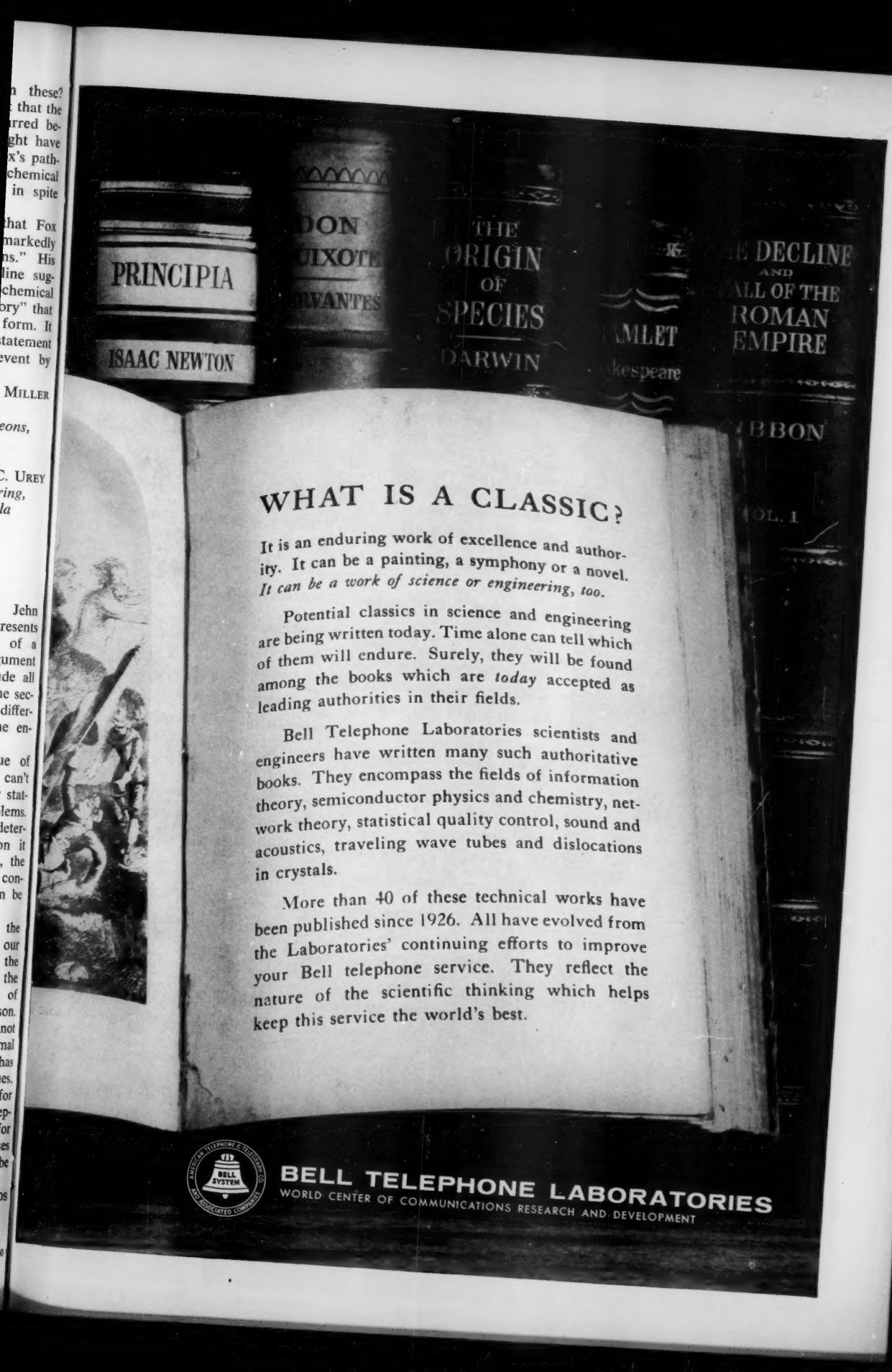
## Discomfort Index

The letter by Kenneth H. Jehn [*Science* **130**, 826 (1959)] presents two arguments against the use of a "discomfort index." The first argument is that the index does not include all the factors that affect comfort. The second is that there are individual differences in personal reaction to the environment.

These two difficulties are true of many indexes now in use. You can't declare an index useless merely by stating the existence of these problems. The usefulness of an index is determined by how much information it yields in spite of these difficulties, the value of this information, and the convenience with which the index can be computed.

As a most elementary example, the spoken word is a useful index to our thoughts and emotions in spite of the fact that words cannot express all the factors involved and the meaning of words varies from person to person. The existence of difficulties does not render speech useless. In a more formal manner, the science of statistics has developed quite a body of techniques, some of them quite elementary, for reducing the number of factors in representing a complex process and for expressing information about processes that are so complex as to appear to be random.

NICHOLAS E. MANOS
*National Aeronautics and Space Administration, Washington, D.C.*




# WHAT IS A CLASSIC?

It is an enduring work of excellence and authority. It can be a painting, a symphony or a novel. *It can be a work of science or engineering, too.*

Potential classics in science and engineering are being written today. Time alone can tell which of them will endure. Surely, they will be found among the books which are *today* accepted as leading authorities in their fields.

Bell Telephone Laboratories scientists and engineers have written many such authoritative books. They encompass the fields of information theory, semiconductor physics and chemistry, network theory, statistical quality control, sound and acoustics, traveling wave tubes and dislocations in crystals.

More than 40 of these technical works have been published since 1926. All have evolved from the Laboratories' continuing efforts to improve your Bell telephone service. They reflect the nature of the scientific thinking which helps keep this service the world's best.

BELL SYSTEM
AMERICAN TELEPHONE & TELEGRAPH CO. AND ASSOCIATED COMPANIES

**BELL TELEPHONE LABORATORIES**
WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

One of a series

# The revealing face of an iron crystal

A single crystal is an ideal system for studying the solid state. Physicists at the General Motors Research Laboratories have turned to whisker-like growths of nearly perfect single iron crystals to investigate three intriguing phenomena: magnetic domains, dislocation defects, and—more recently—high temperature oxidation.

In this latest study, the two crystallographically different surfaces found on iron whiskers are being used to examine the anisotropy or axial-dependent nature of the oxidation process. In early stages of oxidation, the oxide patterns that form on clean surfaces have been found to be strongly dependent upon the orientation of the underlying crystal. In later stages of oxidation, tiny oxide "cilia" actually grow on the surface of the iron whisker. But these new whiskery forms of oxidation are no longer related to the crystal's surface arrangement. The next step in this program involves correlating the oxidation behavior with lattice structure defects such as vacancies and dislocations.

This type of solid state research is revealing the atomic processes underlying strength, magnetic characteristics, and corrosion resistance of metals. At GM Research, we believe the solution to practical problems is increasingly dependent on fundamental information such as this. And each solution enables us to continue to provide "More and better things for more people."

GENERAL MOTORS RESEARCH LABORATORIES

Early Oxidation (750x)

Oxide Whiskers (12,000x)

Reduction of Oxide Products (2500x)

11 December 1959, Volume 130, Number 3389

SCIENCE

AMERICAN ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE

**Board of Directors**

PAUL E. KLOPSTEG, *President*
CHAUNCEY D. LEAKE, *President Elect*
WALLACE R. BRODE, *Retiring President*
H. BENTLEY GLASS
GEORGE R. HARRISON
MARGARET MEAD
THOMAS PARK
DON K. PRICE
MINA REES
WILLIAM W. RUBEY
ALAN T. WATERMAN
PAUL A. SCHERER, *Treasurer*
DAEL WOLFLE, *Executive Officer*

**Editorial Board**

DONALD J. HUGHES — H. BURR STEINBACH
KONRAD B. KRAUSKOPF — WILLIAM L. STRAUS, JR.
EDWIN M. LERNER — EDWARD L. TATUM

**Editorial Staff**

DAEL WOLFLE, *Executive Officer*
GRAHAM DUSHANE, *Editor*
JOSEPH TURNER, *Assistant Editor*
ROBERT V. ORMES, *Assistant Editor*

CHARLOTTE F. CHAMBERS, SARAH S. DEES, NANCY S. HAMILTON, WILLIAM HASKELL, OLIVER W. HEATWOLE, YUKIE KOZAI, MILDRED L. MACE, ELLEN E. MURPHY, ELEANOR D. O'HARA, BETHSABE PEDERSEN, NANCY L. TEIMOURIAN, LOIS W. WOODWORTH

EARL J. SCHERAGO, *Advertising Representative*

SCIENCE, which is now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at National Publishing Company, Washington, D.C. The joint journal is published in the SCIENCE format. SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

**Editorial and personnel-placement correspondence** should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts and illustrations, see *Science* **125**, 16 (4 Jan. 1957).

**Display-advertising correspondence** should be addressed to SCIENCE, Room 740, 11 West 42 St., New York 36, N.Y.

**Change of address notification** should be sent to 1515 Massachusetts Ave., NW, Washington 5, D.C., 4 weeks in advance. If possible, furnish an address label from a recent issue. Give both old and new addresses, including zone numbers, if any.

**Annual subscriptions:** $8.50; foreign postage, $1.50; Canadian postage, 75¢. Single copies, 35¢. Cable address: Advancesci, Washington.

## Scholars in Spite of Ourselves

There is fear these days that Soviet foreign policy is now the determining force in American educational practice, and that the East-West struggle is compelling us more and more to emphasize science at the expense of the humanities. Admittedly, science and technology are becoming increasingly important in international relations, not only as the underpinning of military and economic strength, but also as symbols of power in their own right. The fear is, however, that our efforts to provide an educational basis for our national need will turn us into a country whose citizens will possess no more vision that the machines they soon will all be operating.

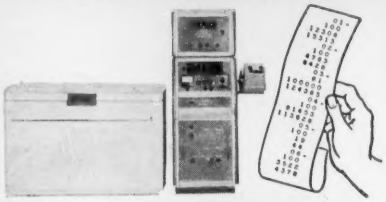
At the risk of seeming to find good in everything, may one say in reply that a kick from behind can propel you ahead? The fact is that if we are being pushed by Soviet action, then at least some parts of our educational system are being pushed in the right direction. If we consider the issue of the proper curriculum not as one of science versus the humanities, but as one of fundamentals versus applications, of gaining understanding versus memorizing rules, then we are presented with a happy paradox. In the present efforts at redesigning high-school science and mathematics programs, the more a course is revised to meet the Soviet scientific and technological challenge, the more it becomes a course appropriate to a liberal arts education.

One of the first and most publicized efforts at reclaiming high-school science teaching, for example, is that of the Physical Science Study Group, based at the Massachusetts Institute of Technology. The group has received considerable support from the federal government, as well as from private foundations, but the physics course it is producing puts more emphasis than is generally found on those concepts like wave motion that are necessary for understanding modern physics, and plays down inquiry into such matters as how a refrigerator works. In its third year of classroom use, the course is now being taught in 600 schools and next year will be made generally available. Other efforts at reform are being developed for courses in other sciences, and the realization is growing that the distinction between teaching underlying concepts and teaching applications applies even to such subjects as arithmetic in elementary school. As Max Beberman of the University of Illinois School Mathematics Project points out in his introduction to a pamphlet issued recently by the Council for Basic Education, children are as interested to learn that the sum of each two odd numbers is an even number as they are to learn that you can cut a yard of ribbon into so many pieces of such and such length.

To study science and mathematics even in the deepest fashion, of course, is not to study the humanities. And if we are happy about the support now available for redesigning science courses, we should be ecstatic if equally large sums were forthcoming for reworking some of the humanities courses. But there is hope that emphasis on science will aid the humanities, if only indirectly, by helping eliminate another kind of specialization. Increased emphasis on science may mean less stress on what the headmistress of a school in a recent novel by Vladimir Nabokov called the four D's—Dramatics, Dance, Debating, and Dating.—J.T.

# Packard Instrument Company...
## *Instruments for Research and Clinical Studies*

**Tri-Carb® Liquid Scintillation Spectrometers**



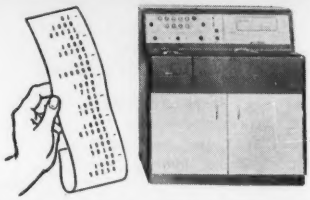
Sensitive, versatile, simple to operate... *accurately* count low-level tritium and carbon-14 and all other beta- and alpha-emitting isotopes.

**These instruments are completely automatic—no staff time is required for counting.**

**Both handle up to 100 samples and record all data in digital form on paper tape. They can be operated on a 24-hour basis.**

●

**Auto-Gamma® Spectrometer Systems**

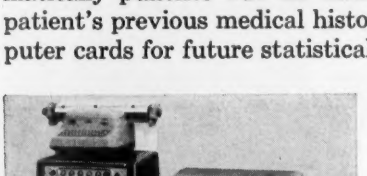


Flexible and accurate... complete *transistorized* automatic systems for counting gamma-emitting isotopes.

**NEW IN METABOLISM STUDIES**

### $CO_2$ ANALYZER

Measures ratio of carbon-12 dioxide to carbon-14 dioxide as well as respiration rate for research and clinical tests. Gives an on-the-spot visible recording. Also automatically punches out all data (including patient's previous medical history) on computer cards for future statistical study.



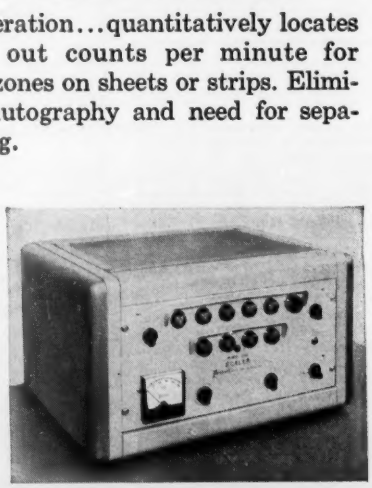
**NEW IN CHROMATOGRAM SCANNING**

### BI-DIMENSIONAL SCANNER

One-step operation...quantitatively locates and prints out counts per minute for radioactive zones on sheets or strips. Eliminates radioautography and need for separate counting.

### SCALER

In geiger, proportional and scintillation counting, this transistorized instrument provides preset time to 100 minutes or preset count to 1 million. Has provision for automatic readout. Compact—no hot electron tubes.



***Request literature giving full details.***

**Packard** *Instrument Company, Inc.*

P. O. BOX 428A • LA GRANGE, ILLINOIS

11 December 1959, Volume 130, Number 3389 SCIENCE

CURRENT PROBLEMS IN RESEARCH

# Animal Domestication in the Prehistoric Near East

## The origins and history of domestication are beginning to emerge from archeological excavations.

Charles A. Reed

The long path in time leads to ourselves from a hominoid group which abandoned forelimb brachiation for hindlimb bipedalism. Once on that path, we can say with the wisdom of hindsight, man was unique as no other animal group ever had been. Combining ever greater skill at abstraction and communication with ever-increasing utilization of energy sources, the main pattern of human culture has led through the successive major steps of tool invention, tool improvement, plant cultivation, animal domestication, urbanization, and political integration, and so finally to the industrial revolution. Looking forward, this path bids to lead us to other planets and other planetary systems.

Seen thus in the long perspective, the initiation of cultivation and domestication—the Neolithic or "food-producing revolution" (*1*)—was one of three or four great cultural innovations, and a fundamental and necessary prelude to civilization (*2*, *3*). (I claim no originality for the above ideas; they are discussed at length in many anthropological writings.) It is true, however, that in spite of our certainty that agriculture and stockbreeding must have had beginnings, changing man from a roving hunter and gatherer to a settled village-farmer, and in spite of our knowledge of the vast ultimate consequences of this technical revolution, we know as yet very little about the details of these origins. Archeology, the discipline upon which we have traditionally depended for our understanding of these beginnings, has been either uninterested—spending its vigor instead in more glamorous pursuits—or incapable of the fine analyses necessary (*4*). For we have here a difficult field of paleonatural history, where the geomorphologist, climatologist, soil scientist, paleoethnobotanist, agronomist, ecologist, geneticist, taxonomist, and comparative anatomist must add their skills to those of the field archeologist. Not all of them have yet done so, and certainly the future will witness greater coordination all along the line.

The literature which shows the attempts of an earlier generation of Near Eastern archeologists to be their own natural-history experts, particularly in the field of zoological identification, is generally a sorry one and should be quietly disregarded. Inevitably and unfortunately, however, the conclusions published in these primary sources are those which have become crystallized into subsequent review papers and textbooks. Too often, also, the intriguing discoveries of the cultural complexity uncovered in the daily digging (particularly in the mounds representing remains of prehistoric towns) argued so strongly for an agriculturally based economy with assured food production that flocks and cultivated fields were assumed. Since the actual proof of the presence of the plants and animals was not thus regarded as necessary, the carbonized grain and the broken animal bones, which should have been considered of primary importance whenever they were uncovered, were too often shoveled onto the dump heap (*5*).

Often, simply, the archeologists of an earlier day—trained as they were in the arts, and in the literature of classical or Biblical history—simply did not know what to look for, and the institutions financing them were not interested in excavating for "natural" (nonartifactual) materials which yielded merely ideas. Instead, the archeologists sought what their home institutions expected of them: display objects, written records, sculptures, and monuments. The more subtle interpretations that are made possible by the cooperation of teams of archeologically oriented natural scientists, working at the excavation, have thus only recently become intellectually and financially possible, and even now the budgetary problems involved in including all of the desired personnel in a major archeological expedition are very great (*6*).

With the exception of a forthcoming book by F. E. Zeuner, none of the major works on the origins of animal domestication (*7*) are in English; this field of study has been preeminently a German one. Previous summaries were limited (as is always the case) to the knowledge available at the time; most such information was of the European Neolithic and the *historical* periods (as gleaned from writings and pictures) of the ancient Near East. Except for the peripheral Iranian site of Anau (*8*), little was known of the all-important late *prehistoric* cultures of southwestern Asia—the cultures actually representative of the period and the area of incipient domestication.

The more recent summaries on domestication by Herre (*9*) are those of an

The author is associate professor of zoology at the College of Pharmacy, University of Illinois, Chicago, and is the zoologist member of the Iraq-Jarmo and Iranian Prehistoric projects of the Oriental Institute, University of Chicago.

experienced morphologist with full knowledge of modern taxonomic practice and evolutionary theory, yet these do not attempt to make an evaluation of the kind attempted here—a critical analysis of our present knowledge of particular phases of the origin of animal domestication by one who has collected and worked in southwestern Asia, who has excavated much of the pertinent material at several of the most important sites, and who is studying the collections from these and other important sites.

## Difficulties

In spite of a prolific literature, dating well back into the 19th century, the central problems concerned with the origins and early history of animal domestication remain unsolved. In large part, as mentioned, this unfortunate situation is due to archeology's not having asked itself the right questions, or, if it has done so, to its having assumed the answers without having saved the evidence. Thus, too many of the reports on prehistoric Egyptian and southwestern Asian cultures merely assert the presence of domestic animals without offering any anatomical proof.

Even if saved, the "evidence" may well run to tens of thousands of broken animal bones, which have to be cleaned, sorted, and individually studied in an effort to identify the bone and to determine the age, sex, and species of the animal (when this is possible). Where wild and domestic forms existed together in the same area, attempts must be made to segregate them.

Heretofore, a major deficiency in attempting in America to study the faunal remains from archeological sites in the ancient Near East has been the almost complete lack of comparative skeletal material with which to make correct identifications. Ideally, one should have complete skeletal series of all the species which existed in the area of the prehistoric culture, to allow one to study age, sexual and individual differences, and differences between wild and domestic forms of the same species. But far from having such series, we had, until recently, practically no study skeletons from the Near East in the Western Hemisphere; indeed, several of the species have become extinct within historical times, and others are perilously near that state. However, a beginning, at least, of such a collection has now been gathered and is available for study in Chicago (*10*).

Piles of dirty broken bones have little appeal to most zoologists, busy with their own researches, nor is the upper Quaternary (particularly the sub-Recent, with its modern-type fauna) of interest to most paleontologists. Such problems really, then, must be undertaken by zoologists who know the area concerned and who have collected in it, who have worked cheek-by-trowel with the archeologists, and who are not only ecologically sensitive to the environmental problems presented but are also anthropologically oriented to the nuances of evolving human cultures. Such zoologists are few [although the field, open and new, will be a promising one once it acquires the respectability of institutional support (*4*)].

Under these conditions, even when osteological collections from important sites have been made, the bones have sometimes lain around for years while the archeologist vainly tried to get someone to study them. Perhaps finally succeeding, he has in turn too often been handed a list of generic and specific names, meaningless to him, to be duly published as an appendix to the site report.

Without interpretation, both environmental and cultural, biological studies related to prehistoric sites have practically no meaning.

Another basic difficulty—aside from the fundamental one of the tremendous expense of putting properly staffed expeditions into the field halfway around the world—is the real paucity of fundamental evidence to date. We have less than a dozen sites in the time range immediately prior to incipient domestication (and not all of these have been studied in detail or published completely), and we have fewer yet for the suspected crucial period of actual domestication. Furthermore, due to political accidents of modern history, these sites cluster either in Palestine or in Iraq, with the intervening gap archeologically unexploited.

A last difficulty, and at the moment one of the most frustrating, is the failure of the radiocarbon ($C^{14}$) technique to yield dates of certain dependability. Although it was hailed as the answer to the prehistorian's prayer when it was first announced, there has been increasing disillusion with the method because of the chronological uncertainties (in some cases, absurdities) that would follow a strict adherence to published $C^{14}$ dates. This is not to question the validity of the physical laws underlying the principle used, or the accuracy of the counters now in operation around the world; the unsolved problem, instead, seems to lie in the difficulty of securing samples completely free from either older or younger adherent carbon. At least to the present, no kind or degree of chemical cleaning can guarantee one-age carbon, typical only of the time of the site from which it was excavated. What bids to become a classic example of "$C^{14}$ irresponsibility" is the 6000-year spread of 11 determinations for Jarmo (*3*), a prehistoric village in northeastern Iraq, which, on the basis of all archeological evidence, was not occupied for more than 500 consecutive years.

## The Problem

What is needed—and what the various members of the Iraq-Jarmo Project are trying to accomplish—is a thorough analysis of all the evidence bearing on the origins of agriculture, animal domestication, and the village-farming way of life. The parts of the problem have different degrees of dependence upon each other (for instance, most of the geological and climatic events would have transpired in the absence of man), but all are intertwined. One cannot think of domestication, thus, as happening independently of the geographical factors (terrain, climate, flora) that always determine animal distribution, or independently of the culture—including the primitive agriculture—of the domesticators.

We must then, like good reporters, try to answer the five *W*'s and the lone *H*: When, Where, Who, What, Why and How?

## When

Although it has been suggested that reindeer were domesticated during the upper Paleolithic in western Europe (*11*), no real evidence of animal domestication can be shown for any Pleistocene period (*12*); we are dealing entirely, so far as is known, with terminal-Pleistocene and post-Pleistocene phenomena.

Stockbreeding, assuring a steady supply of animal fat and protein, came somewhat later than incipient plant cultivation—so far as we know. (The necessarily recurrent use of the phrase "so far as we know" illustrates how badly needed are thorough investigations of sites falling within the time range of "incipient cultivation" (*3*, *13*), when

animal domestication was also undoubtedly being initiated.) There is no *proof* as yet that any of the "incipient-cultivation" sites known—Karim Shahir (*2*), Zawi Chemi (*14*), Mallaha (*15*), and the various Natufian sites in central Palestine—had domestic food animals, and I personally am doubtful concerning the presence of the Natufian dog (discussed below).

Although we must be properly cautious in accepting as valid any lone $C^{14}$ determination from an individual locality, the four available dates for sites of the period of incipient cultivation have a comforting closeness in time, being close not only to each other but also to what we had expected on the basis of accumulating evidence of the last few years. The date for the short-time occupation site of Zawi Chemi is 10,870 ±300 years and that for a typologically contemporaneous level in nearby Shanidar Cave is 10,600±300 years (*16*). Two determinations for Early Natufian levels at Jericho are 9850±240 years and 9800±240 years (*17*). Since milling stones were present at Zawi Chemi and mortars and pestles, plus flint sickles, are known from early Natufian sites in Palestine, we can say, in easily remembered round numbers, that by approximately 10,000 B.P. (before the present), reaping and milling of wild cereals was most probably a reality, with purposeful planting a possibility.

Domestication of the primary food animals followed (*18*)—but by how long? We cannot be certain as yet. I am convinced, however, that in the somewhat later village-farming community of Jarmo we have found multiple specimens of domestic goats, as indicated by the shape of the male horn cores. The time is difficult to assess, in view of the

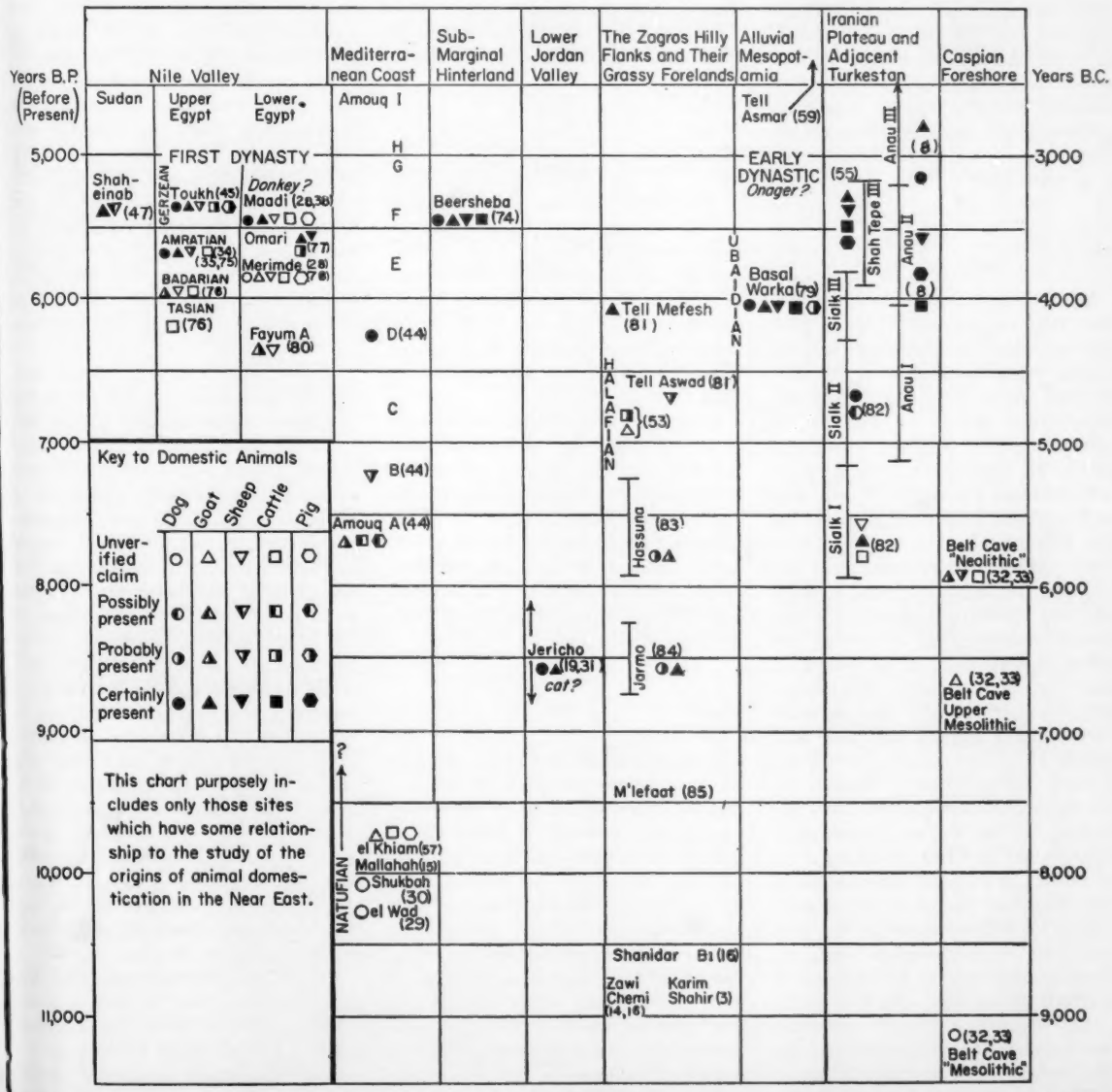



Fig. 1. A chronological chart, subdivided into geographical areas, of the known history of animal domestication in the prehistoric Near East. The estimated time is not to be regarded as absolute; the top of each column is fairly well fixed, temporally; but any part of any column may become elongated or shortened as a result of future discoveries (*73*).

6000-year spread of $C^{14}$ "dates," but probably Braidwood's estimate (*3*) of about 8500 B.P. is as accurate as any that can be obtained now. The conclusion that the domestic goat was present in an early level at Jericho (Tell es-Sultan), although based at first on a single male horn core (*19*), has since been verified by finding additional material (*20*).

There is no *proof* as yet of domestication of any other food animal at Jericho or Jarmo (see the discussion below concerning the dog), or for some time thereafter.

Thus, at present we can only say that domestication of the goat probably falls within the millennium between 9000 and 8000 B.P., and that the domestication of the other three primary food animals (cattle, sheep, pigs) followed some time thereafter (see Fig. 1). We cannot say anything as yet, however, about the absolute time or the chronological order of domestication of these three.

## Where

All archeological work to date in the Near East suggests that both agriculture and animal domestication (with the possible exception of that of the dog) had their origins in the hilly, grassy, and open-forested flanks of the Zagros, Lebanese, and Palestinian mountains (see Fig. 2). These data have been treated fully elsewhere (*2, 3, 21, 22*) and need not be repeated here. On the basis of the data assembled by Dyson (*22*) and of recent archeological evidence from central Asia, the highly respected ethnologist von Fürer-Haimendorf (*23*) has strongly discounted the old notion that animal domestication arose during an early stage of pastoralism. He stressed that, although the dog appeared with preagricultural hunters, the basic food animals always appeared in a context of early village-farmers. Further, he said, the domestication of the horse and reindeer, it must now be realized, came relatively late and had no influence on the earliest agricultural communities or their immediate historical derivatives.

From the primary center in the open-forest hills of southwestern Asia, the village-farming way of life diffused in all directions, carrying with it its trademarks: the village, cereal agriculture (wheat and barley, primarily), and the basic domestic food animals. In Egypt, in Thessaly, in Baluchistan and the Indus valley, probably even in China (at least in northern China), the beginnings of village-farming life were later and seem to have received a cultural stimulus from southwestern Asia.

The case of Egypt is particularly instructive, as wheat, goats, and sheep do not occur wild in Egypt [nowhere in Africa do true sheep and goats occur wild (*24*)] and so, obviously, were introduced as cultivated and domesticated species. If the radiocarbon dates for the Egyptian Fayum are accurate (possibly they are not, as we do know of some later radiocarbon dates for Egypt which are obviously too recent), the earliest and simultaneous appearance of cereal agriculture and domestic goats (or goats *and* sheep?) in Egypt, at Fayum, was considerably later (about 6200 B.P.) than the probable time of their earliest associations in Asia (about 8500 B.P.).

## Who

The people who first turned the trick —who first grew grains and domesticated hoofed mammals—were, on the basis of skeletal evidence, modern-type men of the Mediterranean race. Doubtless they would pass unnoticed, if suddenly resurrected, among the people of today in the hill country where they lived.

Questions arise, to which we have no answers: Would the "agricultural revolution" have had its start where and when it did if another people, of different color or head shape, had lived there? Or would these important events have occurred if our same Mediterranean peoples had had, by a historical accident, some slightly different cultural pattern?

## What

It seems logically probable—although we have as yet no direct evidence—that the cultivation of wheat and barley (or, at first, possibly of wheat alone) induced (or should we be more cautious, and say "allowed"?) the formation of the permanent villages. Probably both agriculture and village development were a necessary prelude to domestication of the basic food animals, although there are contrary views (*25*). These food animals, which undoubtedly contributed so much to the evolution of late prehistoric cultures in the Near East, were goats (*Capra hircus*), sheep (*Ovis aries*), cattle (*Bos taurus*), and pigs (*Sus scrofa*) (*26*). The dog (*Canis familiaris*) was also undoubtedly present (although its presence is poorly documented) but probably did not enter importantly into the cultural picture of the increasingly more complex village-farming and town-farming communities.

In addition, the zebu (*Bos indicus*) was certainly present prehistorically in Baluchistan (*27*), and subsequently in the Indus valley. This whole area, however, is peripheral to the central (or "nuclear") Near East with which we are mainly concerned, and the earliest suggested date for domestic cattle (about 5000 B.P.) is late by Near East standards. The donkey (*Equus asinus*), domesticated from the Nubian wild ass, is of a similar antiquity, having been reported from the site of Maadi in Lower Egypt (*28*). By this time, too, the Syrian onager (*Equus hemionus hemippus*) probably had been domesticated in Mesopotamia. The other domestic animals, both birds and mammals (ducks, geese, chickens, horses, camels, yaks, water buffaloes, reindeer, rabbits, and so on), which we rightly consider to be and to have been important in various human cultures, were not present as domesticants in the late prehistoric of the Near East and so are not here considered.

*Dog* (*Canis familiaris*). Since Bate (*29, 30*) announced that a domestic dog was present in the Natufian period, prehistorians have generally assumed that the dog was the Near East's first domestic animal, ubiquitously present for a period of nearly 10,000 years. However, examination of her published reports and figures has not convinced me that she excluded the possibility that the bones being considered were those of the large Egyptian or golden jackal, *Canis aureus lupaster*, possibly still present in Palestine. If the Natufians did not have a dog, then the earliest records would seem to be from the 7th millennium B.C., by which time dogs are known from the Maglemosian period in northwestern Europe and from Jericho in southwestern Asia. Domestic goats are also known at this time, however, from both Jericho and Jarmo, so we can no longer be so certain that the dog was "the first domestic animal," as has been so glibly stated for decades.

The earliest valid evidence of the dog in all the Near East is from a lower "plaster-floor level" at Jericho (*31*); dogs nearly as small as fox terriers are reported, while others are almost the size of wolves. The status of an even earlier "dog" from Belt Cave in Iran, with a $C^{14}$ age of 11,480±550 years (*32, 33*)

must await the result of a study by a specialist in canid osteology.

I have not been able to convince myself that there were dog bones among the midden remains from Jarmo, although wolf and fox have been identified. However, since the bones are all extremely fragmented, a large dog could easily be mistaken for a wolf. The best evidence for a Jarmo dog is cultural, not zoological; several clay statuettes of what certainly appear to be dogs (the tail is curled over the back) have been found among several thousand statuettes, many of them identifiable as mammals native to the area. Even when identifiable as goats or sheep, however, these figurines are too crudely modeled to yield any clues about domestication.

In Egypt the first valid evidence of the dog is also artifactual; four dogs, led on leashes by one man, are represented on a pottery bowl (*34, 35*) of the Amratian period. They already show characters of the greyhound or seluki type, which by this time is also known (although the build is somewhat sturdy) from the Ubaid period in Mesopotamia by skeletons and, from a somewhat later time, by carvings on cylinder seals (*36; 37*, plate iv*a*). The presence of this specialized breed at this time at both ends of the Fertile Crescent indicates a long, although undocumented, period of artificial selection in the Near East. Not until the late Gerzean period do we find definite skeletal evidence of the dog in Egypt (*38*).

The general lack of skeletal evidence of prehistoric dogs in southwestern Asia and in Egypt is probably in part a reflection of the lack of attention given to such skeletal materials when they were found by archeologists during the last century, but perhaps in part it reflects the fact that dog carcasses were more likely to be available to scavengers than were the bones of the food animals. Perhaps, too, dogs were relatively rare as compared with the hoofed domesticants.

The wolf (*Canis lupus*) has generally been regarded as the ancestor of the dog. This supposition has been based (i) on the great morphological similarities, particularly as to dental details, between the wolf and the earliest dogs of the Mesolithic of western Europe; (ii) on the complete interfertility of dogs and wolves (with fertile hybrids); and (iii) on the great similarity of behavior (*39*).

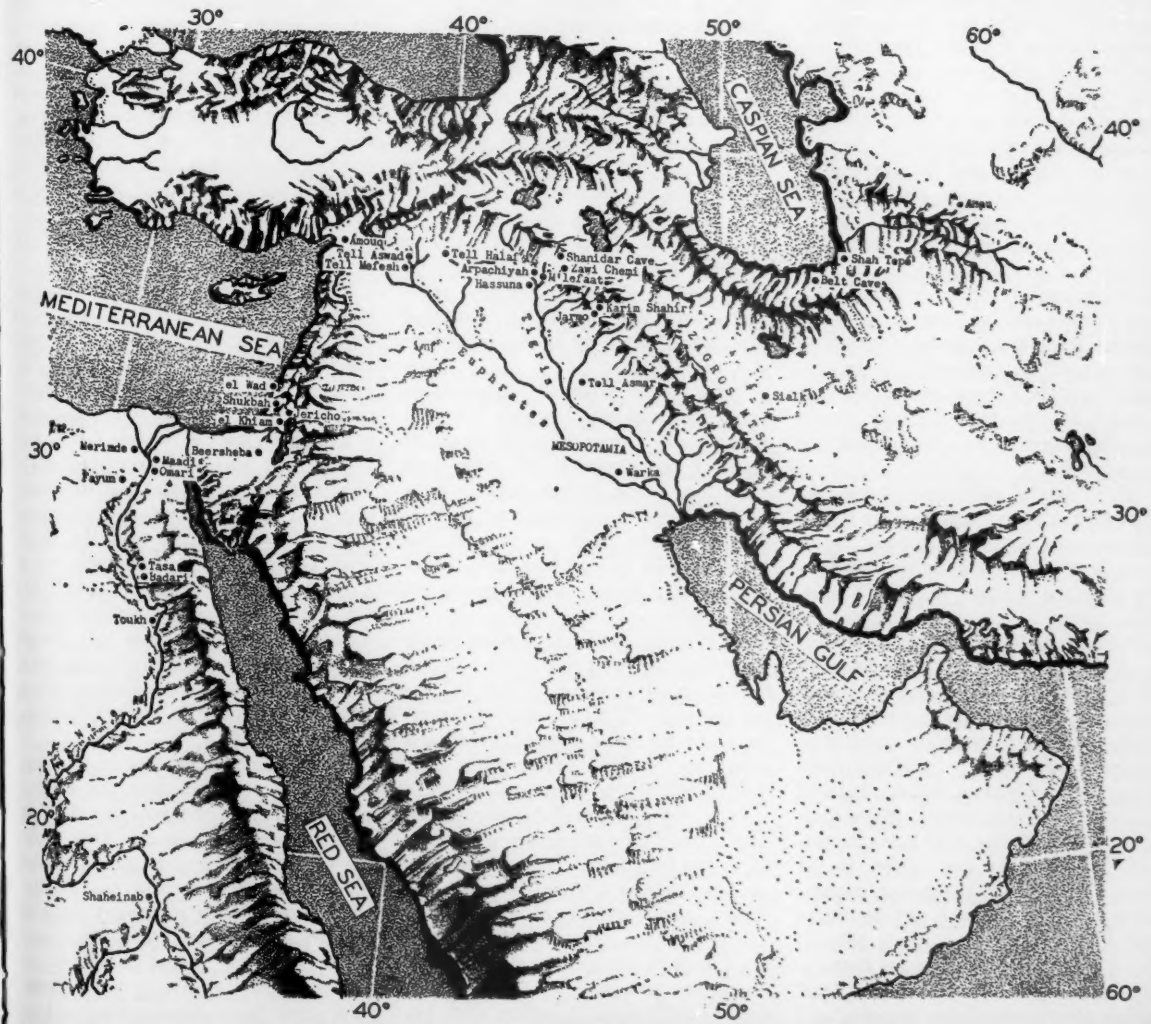



Fig. 2. The Near East. Of the numerous archeological sites which have been excavated in the area shown, only those are included here which have some relation to the study of the origins of animal domestication.

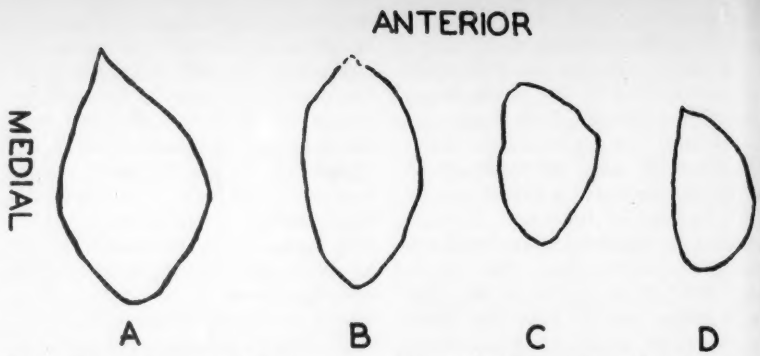



Fig. 3. Cross sections of male horn cores of typical wild and domestic goats, at approximately one-third of the distance from the base of the core toward the tip. All are from northeastern Iraq. (*A*) Right horn core of a wild goat (*Capra hircus aegagrus*). Note the general quadrilateral shape (Chicago Natural History Museum specimen No. 84493). (*B*) Left horn core of a domestic goat from prehistoric Jarmo, drawn as if from the right side. This core is similar in its lozenge shape to the core of the first domestic goat from prehistoric Jericho (*19*) (Iraq-Jarmo field specimen No. J55-194). (*C*) Right horn core of a domestic goat from prehistoric Jarmo. Note the flattening of the medial surface (Iraq-Jarmo field specimen No. J55-191). (*D*) Right horn core of a domestic Kurdish goat, killed in 1955. Note the flattening of the medial surface (Chicago Natural History Museum specimen No. 57253). (×0.82)

In spite of such evidence, however, several authors have suggested the golden jackal, *Canis aureus*, as the dog's ancestor, usually admitting later admixture with wolves for the more boreal breeds (*40*). Certainly Bate (*29*) regarded the supposed "dog" from the Natufian of Palestine as jackal-ancestored (although, as mentioned above, the animal may well *be* jackal and not dog). However, dog and jackal are dissimilar with respect to certain definite dental characters, and they have a different chromosome number (dog, 78; jackal, 74) (*41*). While dogs and jackals do interbreed, the fertility of the resulting hybrids seems not to have been established with the certainty usually assumed. Although the problem cannot be said to have been settled and there may have been some interbreeding of dogs (once established) with jackals, the preponderance of evidence indicates the wolf as the primary ancestor of the first dogs. The third possibility, that a hypothetical "wild dog" (*42*) or the pariah dog (*43*) actually represent an ancient stock from which the domestic dog was derived, lacks any historical evidence and fails to find (in my opinion, at least) the necessary paleontological support.

*Goat (Capra hircus) and sheep (Ovis aries).* Most of the bones—although not the horn cores or metapodials—of these two species are so similar that the species are often included together as "sheep/goat" or "caprovid" in archeological reports. Even when they are supposedly distinguished, one must always be suspicious of the validity of the identification.

Much careful archeological and zoological work remains to be done before we can know certainly whether sheep or goats were domesticated first, but present evidence indicates it was the goat. With goats, as with other animals, the earliest domesticants would be identical with, or very similar to, the wild form. Only after many generations could mutations accumulate that would so mark the domestic population that their broken bones would be distinguishable from those of wild individuals brought into the village by hunters. (Even now, where it is available, wild game is typically brought into the villages in the Near East for food.) However, population-age analysis based on the bones may show a shift from a stratigraphically lower level with random age distribution to a higher, and thus later, level with a greater proportion of young and near-mature animals. Such a shift would certainly suggest a change from wild-killed animals to domesticated ones, most members of the herd being harvested at optimum times. It is on the basis of this type of evidence, although on a rather limited series, that Coon (*32*) made a claim for the domestication of goats and sheep at Belt Cave in northern Iran ($C^{14}$ date of about 8000 years ago). At or before this time, however, domestic goats—as identified morphologically—are known from Jericho and Jarmo.

These Jarmo goats are distinguished from the wild type (which are also numerous in Jarmo) primarily by differences in the shape of the male horn core (Fig. 3) and, furthermore (in some of the Jarmo specimens), by a slight twisting of the horn. In contrast, the horns of wild goats, while curved over the animal's back like a scimitar, are not twisted.

Most of the archeological work in the Near East has been so lacking in attention to animal remains (*5*) that we cannot be certain of the presence of domestic sheep for some thousands of years after the probable beginning of that domestication.

It would seem probable that sheep would have been domesticated as early as, or not long after, goats. Whereas we do have definite evidence of many domestic goats at Jarmo and Jericho (about 8500 B.P.), the records for sheep are extremely meager [if all unverified claims are discounted (*5*)] for the succeeding 2500 years. Amschler (*44*) has reported both domestic and wild sheep from the Amouq sequence, but the sheep bones are exceedingly rare in comparison with the other domestic artiodactyls. It is only *after* 6000 B.P. that we find convincing evidence of sheep, from the Gerzean period in upper Egypt (*45*), Warka in Sumerian Mesopotamia (*37*, plate iii*a*), and the Anau II level (*8*) in what is now the Turkoman S.S.R.

Throughout much of this period, between about 8500 and 6000 B.P., our record for goats is little better than that for sheep, but by the latter part of the period these domestic animals were probably raised not only in upper Egypt but up the Danube as well (*46*), and only a little later in Baluchistan (*27*). The goat, curiously, was late in reaching north into the oases of west-central Asia; it is reported only from the upper levels of Anau, whereas domestic sheep are definitely known earlier there (*8*). Up the Nile, however, goats—albeit dwarfs — seemingly preceded sheep; goats are known from the Sudan about 5300 B.P., while the contemporaneous evidence for sheep is meager and uncertain (*47*).

If we assume, as we must on the basis of present evidence, that the earliest domestication of the goat occurred in southwestern Asia, there is little problem concerning the identity of the wild ancestor, as there *is* only one population (*Capra hircus aegagrus*) of wild goat in southwestern Asia. The ibex, various species of which occur in Europe, Africa, and Asia, has presumably never been domesticated and so does not complicate the problem, and the only other goat, *C. falconeri*, lives

further east. With sheep, however, the pattern is not clear at all, due to multiple and conflicting taxonomic and nomenclatural problems. Students of domestication have argued endlessly about which kinds of sheep were evolved from which species of wild sheep, without ever really knowing what a species of sheep is, how many valid species occurred (if there was more than one in central and western Eurasia), how much actual interbreeding (and thus gene-flow) occurred between the different populations variously described as species or subspecies, or what genetic factors underlie the characters of horn, head, tail, and fleece that have been so ardently discussed.

The genetics of most of these characters is still largely unknown, and a true classification of Old World *Ovis* is now extremely difficult, due to dwindling numbers of many of the populations (*48*). However, if it were sufficiently comprehensive, a gene-frequency study (*49*) of ovid blood factors (potassium and sodium concentrations, hemoglobin types, blood groups), of both wild and domestic sheep would undoubtedly help clarify the muddled taxonomic situation and would also aid in tracing the ancestries and interbreedings of the different races of domestic sheep. Additionally, detailed study of many bones from many archeological sites would give valuable collaborative evidence with historical depth. Until such data are forthcoming, I prefer the simplified taxonomic scheme of Tzalkin (*50*), who believed that, aside from *Ovis canadensis* of far eastern Siberia, all the Old World sheep belong to several subspecies of but one species, *O. ammon*. Thus, the detailed anatomical differences which have been so thoroughly studied and discussed by many students of sheep domestication in tracing the phylogeny of different breeds would never have had more than subspecific value.

*Cattle (Bos taurus).* The large, long-horned, wild *Bos primigenius* illustrated with such magnificent artistry at Lascaux, hunted and portrayed by the Assyrians, described with wonder by the Romans, and extinct in 1627, was distributed throughout the forested regions of Europe, North Africa, and southwestern Asia into historic times. Whether or not a second, short-horned species (*B. longifrons*) occupied much of the same area has been endlessly disputed; perhaps these short-horned animals were merely females of *B. primigenius* (*51*).

In addition, the European bison (*Bison bonasus*) extended its range into southwestern Asia, and in Iraq, at least, a wild water buffalo (*Bubalus*) undoubtedly existed (*52*). In the marshes of the Nile of prehistoric Egypt, in addition to true wild cattle, probably at least one kind of African buffalo (possibly two) existed (*5*).

The simultaneous presence of these several Bovini in the Near East, the nuclear area of animal domestication, is important—primarily because of the very fact that it has been generally disregarded. The result has been that any large bovines from prehistoric sites have usually, in the archeological literature, been labeled "domestic cattle" if, in any particular archeologist author's opinion, the time range fell within the limits of expected animal domestication. Generally the very real problem of the great difficulty of distinguishing between these various genera, particularly on the basis of a few teeth or broken bones, has simply not been recognized. Additionally, there is the much greater problem, even if the animal is *Bos*, of determining its status—wild or domestic.

The value of the scientific material relative to large bovines that has been thrown away unstudied is fantastic; in some cases the "identification" of the native workmen at the excavation has been accepted on the spot, and the skeletons or skulls have been discarded. The result is a woeful ignorance about the origins of cattle domestication; instead of evidence we have sweeping fictions by archeologists and culture-historians concerning the increasing complexity of human cultures throughout later prehistoric times, as based upon the presumed utilization of cattle and other livestock.

Bulls were important in the emotional life of the Halafian people, it is true, as shown by their art and deduced for their religion (*53*); this emotional attachment of people to their cattle is a very real thing, with multiple manifestations, in all cattle-breeding peoples. Probably the Halafian and other Near Eastern peoples of the period *did* have domestic cattle, but the only evidence I can find has been hitherto overlooked (at least, so far as I can discover; certainly evidence has not been demanded in the archeological literature!). The particular item is a small but clear reproduction of a cow's head, from a basal Halafian level at Arpachiyah (*53*), which has horns that are short and curve forward, quite like those of some cows today.

It is not until very late prehistoric times (about 6000 to 5000 B.P.) that we find actual proof, both zoological and cultural, of domestic cattle. The beautifully clear delineations on the cylinder seals of Warka and other early Sumerian towns testifies to the importance of cattle in these communities, as do the careful anatomical studies of Duerst (*8*) and Amschler (*55*) on the cattle bones from the roughly contemporaneous Iranian sites of Anau II and Shah Tepé III, respectively.

In Egypt, throughout this same 4th millennium B.C., most prehistorians discuss with confidence the cattle-breeding cultures of the Badarian, Amratian, and Gerzean periods, without realizing that valid evidence of domestic cattle is lacking. As with the Halafian and some other Mesopotamian periods, the conclusions were too often assumed, while the need for evidence was ignored. Only at the Gerzean site of Toukh (*45*) was a careful study made of the faunal remains; here Gaillard emphasized the resemblance of the excavated bones of the short-horned cattle to those found in adjacent but earlier Paleolithic sites, and also stressed their resemblances to bones of known domestic short-horned cattle, both prehistoric and modern. He never, however, spoke of the Toukh cattle as being domestic, particularly as wild cattle of that type were living in Egypt then and later. Even the relative youth of most of the cattle killed cannot be considered evidence of purposeful control of domestic herds, as the gazelle bones in the same middens were also mainly from subadult individuals. (Were, then, the gazelles perhaps domesticated?)

The prehistorians are probably correct in thinking that domestic cattle were present and important in the human cultural evolution of Egypt of the 4th millennium B.C., prior to dynastic times and the beginning of written history, but these same prehistorians must become aware of the lack of zoological or cultural evidence for their assumptions.

*Pig (Sus scrofa).* During the late prehistoric times here considered, many subspecies of wild pig were native to North Africa and much of Eurasia. In spite of this wide distribution, the ancestor of *all* domestic pigs has been singled out as one southeastern Asiatic subspecies, *S. s. vittatus* (*18, 56*); if it is true that this subspecies is the common ancestor, domestic pigs must have been moved westward, presumably slowly, to reach the Near East and most of Europe in prehistoric times. As yet I have not investigated this problem, but the gen-

eral pattern seems illogical. I suggest that we at least reinvestigate the possibility that domestication of pigs may have occurred several times, from different wild populations.

Pigs are not as difficult to tame as one might imagine; an adult wild boar or sow, it is true, is not an animal one approaches casually, but several people have easily reared the young of wild pigs to adulthood, the females having then produced litters to be reared in captivity (*5*). Such pigs are surprisingly docile.

Although a domestic pig has been mentioned for the Natufian (*57*), the evidence—a single phalanx—is unacceptable. The earliest record to merit serious consideration is that for Amouq A, in the northern Levant. Here, as in later levels of the Amouq sequence, Amschler (*44*) listed both domestic and wild pigs, but without any explanation of his basis for differentiation.

Other than for the Amouq, there is little osteological evidence for the presence of domestic pigs in the prehistoric Near East except in the north across Iran, near the base of Anau II (*8*), where domestic pigs were suddenly introduced with no prior, and little subsequent, evidence of wild pigs having been hunted. By this time (about 3800 B.C.) or before, the pig was quite probably an important food animal in southern Mesopotamia, although this conclusion is based on what I consider to be slight cultural evidence (*58*). Certainly, pigs are known to have been important in Sumer in early historic times. However, the only study (*59*) on the osteological remains from a Sumerian city (Tell Asmar) is from a time so late as not to appear on my chronological chart.

Egypt, it would seem to me, might well have been an independent center of pig domestication, considering its semi-isolated position and late cultural development. It is difficult for me, for instance, to imagine pigs being driven across the desert of Sinai, but the *idea* of domestication could pass readily, perhaps by way of a Syrian visitor. There are numerous pig bones from the sites of Merimde and Maadi in northern Egypt, but there is no published study of them known to me to vindicate Menghin's oft-quoted claim (*28*) that pig breeding represented an important cultural difference between the late prehistoric cultures of upper and lower Egypt. When Gaillard, an experienced morphologist, *did* carefully examine the numerous bones of pigs from the midden of Toukh in upper Egypt he was unable to determine whether the animals had been wild or domesticated (*45*). Domestic pigs may well have been present and important in the economy of prehistoric Egypt, but until we have zoological or cultural evidence for such domestication we must assume that the numerous bones of pigs found in the remains of prehistoric villages represent wild pigs from the adjacent Nile marshes.

## Why

Why did men domesticate animals at all? A religious motif has often been suggested (*42*), but probably at first there was little realization of what was occurring; there was merely a gradual strengthening of an association between two species of social animals (man and dog, man and goat, and so on), preadapted by their respective evolutions to be of mutual benefit. Everything we know about preliterate cultures argues against a sudden realization of the potential values of animal domestication, followed by planned action; man could have had no concept of the future values of animals' milk, or of wool not yet of useful length on the hairy wild sheep. Later, in literate societies, there *were* purposeful efforts at domestication. Some, such as the Egyptian Old Kingdom domestication of the hyena, of certain antelopes, and of the Nilotic goose, were seemingly successful but were later abandoned. The era of planned domestication was not limited to peoples of ancient history, however, for we note the successful 19th-century domestication of the budgerigar parrot and of the laboratory rat. Today, planned domestication of two large mammals is in the experimental stage—that of the eland (*Taurotragus*) in Rhodesia and of the musk ox (*Ovibos*) in northern North America (*60*). The latter experiment, at least, is showing promise of success.

## How

Man probably entered into a state of beneficial mutualism with certain animal species because, to put it in very general terms, the animals were already socially and psychologically preadapted to being tamed without loss of reproductive abilities. A second factor was the necessary one that the human culture milieu had evolved to a state of organization such that the animals could be controlled, and maintained generation after generation in a condition of dependence. At least to some degree the animals must be protected from predators and provided with food—the latter perhaps only in times of scarcity. The detailed pattern of the process leading to domestication naturally varied with both the particular species and the human culture that were interacting; certainly the domestication of the wolf to the dog by the Maglemosian hunter-collectors of northwestern Europe was different in detail from the domestication of the hoofed food animals by the post-Natufian cultivators. Unfortunately, we know nothing of the details of either process, partly because of our inability to reconstruct the behavior and cultural environment of the people involved and partly because of our ignorance of the psychology of the various wild animals involved.

With the exception of one of the most recently domesticated mammals, the laboratory rat, we know little enough about the behavior patterns of our common domestic animals, but we know much less about the behavior of their wild progenitors. Furthermore, detailed comparative observations of wild and domestic *Rattus norvegicus* emphasize the tremendous behavioral changes undergone by a species during domestication (*61*). Thus, psychological studies on domesticants probably cannot yield the total behavior pattern of the wild ancestors. It was, however, these wild ancestors that man first tamed and reared.

The social enzyme that activated the union of man and beast was undoubtedly the human proclivity, not only of children but of women also, to keep pets (*25, 42, 62*), although purposeful capture of young animals by men, to serve as hunting decoys, may well have been another avenue toward domestication.

The psychological factor of "imprinting," explored particularly by Lorenz in a notable series of animal experiments, was undoubtedly a major influence in the domestication of birds with precocial young (chickens, ducks, geese, turkeys, and so on). *Imprinting* refers to the tendency, most pronounced in such precocial birds, to recognize, and psychologically to attach themselves to, the most frequently seen and heard living thing during an early and short "critical period." Typically this would be the mother, and we have thus an instinctive mechanism for recognition of the parent by an active newborn.

For mammals, we probably cannot speak of "imprinting" in as complete a sense as we do for birds. There are, of course, definite sequences of actions whereby mother and young learn to recognize each other; for the young mammal this is certainly a "critical period." Such recognition of the mother is then enlarged to include other members of the species. A lamb reared in isolation, for instance, rather thoroughly ignores other sheep for the remainder of its life (*63*), even though it will mate and produce young. We would seem to have here, in correlation with the abovementioned tendency to keep pets, a mechanism for the switching of psychological recognition and social dependence from a real mother to a human foster mother.

The "critical period" for hoofed mammals—whose behavior is similar in some respects to that of precocial birds—is within a few hours of birth, but for helpless-born young it comes several days or weeks later [three weeks and later for the dog, for instance—a phenomenon associated with myelinization of cephalic neurons (*64*)]. In such mammals, the critical period is probably not so limited in time or so well defined as to pattern as in the hoofed animals. The essential point, however, is that in the domestic mammals that have been studied, and presumably in the others, there is such a patterned behavior system as is here discussed, a biological mechanism so basic that it remains essentially unchanged in the transition from wild to domestic status.

Since the "critical period" in mammals always comes prior to weaning, we must assume that there was a human wet nurse for whatever small helpless suckler might be brought into the village; there are women of primitive tribes who still act thus and provide the proper model (*42*). Once the domestication of sheep and goats had been accomplished and the practice of milking had been established, milk would have been available for orphaned calves and colts, and thus the way for domestication of larger species would have been opened.

It is not, however, only the young of many mammals that can be kept and reared; even the adults of some artiodactyls seem to seek domestication. Arkell (*65*) tells of a female wart hog, with young, that made a nuisance of herself about one of his camps during a famine period, and I myself have had the experience of having my car stopped (*not* during a famine period!) on a major American highway by two large males of that supposedly wild species the big-horn sheep, who then stuck their heads in the open windows begging for tidbits. These animals may not have known it, but they were *asking* to be domesticated.

Once the nuclei of herds had been established, human selection against the aggressive and unmanageable individuals would have been automatic, resulting in the decrease in production, generation by generation, of the adrenocortical steroids (with multiple attendant physiological changes)—a process that has been studied in detail for the short history of the laboratory rat (*61*). Eventually submissiveness becomes genetically ingrained in the population (although some species, such as the sheep, seem more susceptible to such manipulation than others). Furthermore, those animals naturally adapted to breed best in captivity would contribute their characters in larger numbers to the gene pool of each succeeding generation. Such unplanned selection of various sorts must have long preceded the methods of purposeful artificial selection which led eventually to the establishment of different breeds within a domestic species.

However it originated, once domestication had occurred, the idea could be transferred to species other than the original ones—a type of cultural shift which seems to account for the domestication of the reindeer. I find no reason, either, to believe that domestication of the same species could not occur in different places at different times, probably as the result of diffusion of the idea. Thus, pigs and cattle could have been domesticated in both southwestern Asia and in Egypt, the stimulus having been transferred from the former area to the latter in the mind of a human migrant.

A last factor that must be considered in a discussion of the origin of domestication of animals in the Near East is the "propinquity" or "riverine-oasis" theory of domestication (*66*). Briefly, the increasing desiccation of the Saharan and Arabian areas during the post-Pleistocene supposedly enforced the juxtaposition of man and the potentially domesticable animals around the disappearing water sources, leading to conditions of beneficial mutualism and thus to domestication.

Aside from the fact that a variety of ecological and distributional data argue against the validity of such a view (*5*), accumulating evidence indicates that the known climatic sequence itself makes the idea untenable. I suspect that the adherents of the "riverine-oasis propinquity theory" have been overly impressed by the grand sweep of the very real desiccation of North Africa since the Allerod (about 11,000 years ago) without having given due regard to the fluctuating climatological conditions (*67*, *68*) that existed. There were, beginning in the late Pleistocene, several fluctuations of temperature and rainfall which had profound ecological consequences for the biologically sensitive area of North Africa, where the evidence is best known. However, there is no evidence of domestication during the periods in question (about 15,000 to 7000 B.P.) in this or in any other desert area. There then began the "Neolithic wet phase" [Butzer's Subpluvial II (*67*) and Alimen's "second wet phase" (*68*)], lasting from about 7000 to 4500 B.P. During much of this time (*69*) domestic bovids (sheep, goats, and cattle) were present all across the Sahara, as shown by innumerable engravings and paintings (*68*), and the subsequent dramatic desiccation to present conditions thus occurred long after the full pattern of domestication had been established.

The "oasis theory," based as it originally was on an idea of continuous desiccation during the post-Pleistocene North African climatic sequence, loses all meaning when transferred to southwestern Asia, the actual site of original bovid domestication. Here data on Saharan rainfall and temperature fluctuations *may* apply to the central desert areas proper (the evidence is scant and inconclusive) but seemingly have much less meaning elsewhere.

Particularly throughout the hills of the Zagros-Palestinian chain there was relatively little climatic change within the transition period from the upper Pleistocene to the early Recent (*70*); in fact, these terms have relevance in a climatic sense only as we can correlate them with regions of former continental glaciation.

My own unfinished studies on the bones collected from half a dozen sites in northern Iraq, which bridge some 90,000 years of the late Quaternary, show that an essentially modern fauna has occupied the area during this period. This does not mean that there has been no climatic change during this time in these hills and mountains, but it does mean that such variations as have occurred in temperature and precipitation have done little more than simultaneously depress and/or elevate the upper and

lower tree lines. The fauna (including prehistoric man, undoubtedly) moved slowly with the flora to the extent necessary to maintain a fairly static ecologic situation.

We must then face the seeming enigma that cultural evolution occurred even though the Hilly Crescent of southwestern Asia passed through no such end-of-the-Pleistocene environmental crisis as was experienced by Europe, North Africa, and North America. For Europe particularly, with the correlated cultural change from Paleolithic to Mesolithic (a degree of change perhaps often overemphasized), the idea that there was intensive post-Pleistocene human adaptation to changing environments is generally accepted, usually accompanied by the concept (even though unexpressed) of the development of greater cultural complexity ("progress") in answer to the changing conditions.

In southwestern Asia, however, we have at approximately this time the profound cultural change to incipient cultivation, if not to actual cultivation, within that millennium which includes the Karim Shahir and Zawi Chemi materials of Iraqi Kurdistan and the Natufian of Palestine. But here we cannot point to a dramatic climatic change, furnishing a stimulus for sudden cultural evolution.

Indeed, the available evidence is quite the contrary; true, the Natufian had a more complex set of tools than any of its upper Paleolithic predecessors in southwestern Asia, and the culture was marked particularly by large numbers of very small flake tools (microliths) and by the introduction of mortars and pestles for seed grinding, but the whole assemblage is in the blade-tool tradition of some 40,000 years of Levantine history and undoubtedly evolved *in situ*, with a minimum of external influence (*71*).

Still eluding us are the factors that led these particular peoples to inaugurate cereal agriculture, however incipiently, and thus, by way of many changes to furnish the food base of today's technological society. But increasingly the archeologist is looking for a greater variety of data from his excavations and asking different questions of those data. Increasingly, too, natural scientists are helping him collect and interpret that evidence. It is certain that, under these circumstances, we shall be getting more and better answers to our questions concerning the many unsolved problems in the study of the relationships between climate, man, and the origins of agriculture and domestication (*72*).

## Conclusions

Concerning the animal aspect of the "food-producing revolution," present evidence indicates that domestication of goats and sheep occurred in a central core area in southwestern Asia in prehistoric times, probably about the 7th millennium B.C., cattle being domesticated somewhat later, and pigs even later.

Domestication of the food-producing animals probably occurred in village-farming communities in the Hilly Flanks area of southwestern Asia; thus, cereal agriculture and the settled village are considered to antedate the domestication of all animals except the dog.

Present archeological data indicate (although many archeologists have tended to ignore or discard the evidences) that relatively intensive and successful agricultural and stock-breeding (mixed-farming) societies developed in the Zagros hills and their grassy forelands (as well as in the lower Jordan valley) prior to the appearance of the earliest societies of this type elsewhere; similar Iranian and Egyptian cultures seemingly developed later and peripherally. At least for Egypt this seeming lateness—a matter of two thousand years or more—is probably not just a reflection of accidental or incomplete sampling.

No dramatic end-of-Pleistocene environmental change has been detected for southwestern Asia; thus, the all-important "food-producing revolution" was seemingly not stimulated by the challenge of a post-Pleistocene climatic change (*70, 71*).

### References and Notes


1. We are indebted to V. G. Childe for stressing the importance of this fundamental concept. The development of Childe's ideas, which have had such a profound influence on the history of thought, are interestingly outlined in an autobiographical note: V. G. Childe, *Antiquity* **32**, 69 (1958).
2. R. J. Braidwood, *The Near East and the Foundations for Civilization* (Univ. of Oregon Press, Eugene, 1952).
3. ———, *Science* **127**, 1419 (1958).
4. ———, *Natl. Acad. Sci.–Natl. Research Council Publ.* **565**, 16 (1957).
5. These general statements will be discussed and documented more fully in a forthcoming paper (C. A. Reed, *Studies Ancient Oriental Civilization, Univ. Chicago*, in press).
6. W. W. Taylor, Ed., *The Identification of Non-artifactual Archaeological Materials* (National Academy of Sciences–National Research Council, Washington, D.C., 1957).
7. *Domestication* to me means simply that the animals are under the control of man to such a degree that, if he wishes, their choice of mates is determined. Artificial selection is thus possible and usually, to some degree at least, inevitable. In a very important sense, then, domestic animals (as well as plants) are a type of human artifact, since they exist in a form changed by man.
8. J. U. Duerst, *Carnegie Inst. Wash. Publ. No. 73* (1908), p. 339.
9. W. Herre, "Domestikation und Stammesgeschichte," in Heberer, *Evolution der Organismen* (Stuttgart, 1955); "Die geschichtliche Entwicklung der Haustierzüchtung," in Zorn, *Tierzüchtungslehre* (Ulmer, Stuttgart, 1958).
10. A grant from the National Science Foundation to the department of anthropology of the University of Chicago allowed me to spend the year 1954–1955 in southwestern Asia, collecting living animals in addition to doing archeological work with the Iraq-Jarmo Project. The zoological specimens collected were deposited in the Chicago Natural History Museum.
11. E. Patte, *Compt. rend.* **246**, 3490 (1958).
12. I follow the common practice of most European geologists and of the U.S. Geological Survey [H. B. Morrison *et al.*, *Am. J. Sci.* **255**, 385 (1957)] in dividing the Quaternary into Pleistocene and Recent, although at least one eminent authority rejects any such differentiation [R. F. Flint, *Glacial and Pleistocene Geology* (Wiley, New York, 1957)]. The Recent is generally considered to have begun between 10,000 and 11,000 years ago, the difference depending only upon whether the several hundred years of the Younger Dryas is included in the Pleistocene [H. E. Wright, Jr., *Am. J. Sci.* **255**, 447 (1957)] or in the Recent [W. S. Cooper, *Bull. Geol. Soc. Am.* **69**, 941 (1958)].
13. R. J. Braidwood and C. A. Reed, *Cold Spring Harbor Symposia Quant. Biol.* **22**, 19 1957).
14. R. S. Solecki, *Quaternaria* **4**, 1 (1957); *Trans. N.Y. Acad. Sci.* **21**, 712 (1959).
15. J. Perrot, *Antiquity and Survival* **2**, 91 (1957).
16. R. S. Solecki and M. Rubin, *Science* **127**, 1446 (1958).
17. K. M. Kenyon, *Antiquity* **33**, 8 (1959).
18. But see C. O. Sauer, *Agricultural Origins and Dispersals* (American Geographical Society, New York, 1952) for the conflicting opinion that the pig was domesticated earlier, in southeastern Asia, and was then brought westward.
19. F. E. Zeuner, *Palestine Explor. Quart.* **1955**, 70 (1955).
20. Personal communication from F. E. Zeuner, 22 Oct. 1958.
21. R. J. and L. Braidwood, *J. World Hist.* **1**, 278 (1953).
22. R. H. Dyson, Jr., *Am. Anthropol.* **55**, 661 (1953).
23. C. von Fürer-Haimendorf, *Yearbook Anthropol.* **1**, 149 (1955).
24. D. M. A. Bate (*47*) has accepted a description of native goats in Algeria [A. Pomel, *Service Carte Geol. Algeria, Paleontol. Monogr. No. 13* (1898), p. 1], but the age of the materials from which Pomel described these goats is uncertain [C. Arambourg, *Bull. soc. hist. nat. Afrique du Nord* **20**, 78 (1929)], and there is a distinct possibility, thus, that Pomel's "*Capra promaza*" is based upon Neolithic domestic goats.
25. F. E. Zeuner, in *A History of Technology*, Charles Singer *et al.*, Eds. (Oxford Univ. Press, London, 1954), vol. 1, p. 327. This paper is an important one on the "why" and "how" of domestication and forms a foundation for much of what I am saying here, even though I do not agree with Zeuner in every detail.
26. It is interesting to note that all of these animals belong to the same order, the Artiodactyla, and that except for the pig they are not only all ruminants but are all bovids. Other bovids (water buffalo, zebu, yak) were subsequently domesticated, and many species of gazelles and antelopes, particularly, seem to be potentially domesticable. No other family looms so importantly in the history of domestication. Factors involved in the late origin (Miocene) and rapid and successful evolution of the Bovidae may perhaps play some role in their versatile adaptations to domestication. Actually, there may be no bovid which could not be domesticated.
27. W. A. Fairservis, Jr., *Am. Museum Nat. Hist. Anthropol. Paper No. 45* (1956), p. 167.
28. O. Menghin, *Anz. Akad. Wiss. Wien, Phil.-Hist. Kl.* **70**, 82 (1934).
29. D. M. A. Bate, *The Stone Age of Mt. Carmel* (Clarendon, Oxford, 1937), vol. 1, part 2.
30. ———, *Proc. Prehist. Soc.* **8**, 15 (1942).
31. F. E. Zeuner, *Palestine Explor. Quart.* **1958**, 52 (1958).
32. C. S. Coon, *Cave Explorations in Iran 1949* (University Museum, Univ. of Pennsylvania, Philadelphia, 1951).
33. E. K. Ralph, *Science* **121**, 149 (1955).
34. M. Hilzheimer, *Antiquity* **6**, 411 (1932).

35. E. Massoulard, *Trav. et Mem. inst. ethnol. Univ. Paris* **53**, 1 (1949).
36. A. J. Tobler, *Excavations at Tepe Gawra* (Univ. of Pennsylvania Press, Philadelphia, 1950), vol. 2, plate 37b.
37. H. Frankfort, *Cylinder Seals* (Macmillan, London, 1939).
38. Y. S. Moustafa, *Bull. inst. Egypte* **36**, 105 (1955).
39. J. P. Scott, *J. Natl. Cancer Inst.* **15**, 739 (1954).
40. K. Z. Lorenz, *Man Meets Dog* (Houghton Mifflin, Boston, 1955).
41. R. Matthey, *Mammalia* **18**, 225 (1954).
42. C. O. Sauer, *Agricultural Origins and Dispersals* (American Geographical Society, New York, 1952).
43. B. Vesey-Fitzgerald, *The Domestic Dog: An Introduction to Its History* (Routledge and Kegan Paul, London, 1957); F. S. Bodenheimer, *Bull. Research Council Israel* **7B**, 165 (1958).
44. J. W. Amschler, *Identification of the Animal Bones from the Amouq* (unpublished manuscript in the personal files of R. J. Braidwood). This collection of bones from the excavations of the Oriental Institute's Syrian Expedition is now in Chicago and is to be restudied before final publication of the results.
45. C. Gaillard, *Arch. musée hist. nat. Lyon* **14**, 1 (1934).
46. V. G. Childe, *Antiquity* **31**, 36 (1957).
47. D. M. A. Bate, in A. J. Arkell, *Shaheinab* (Oxford Univ. Press, London, 1953), pp. 11-19.
48. F. Harper, *Extinct and Vanishing Mammals of the Old World* (New York Zoological Park, New York, 1945).
49. J. V. Evans, *Advances in Sci.* **13**, 198 (1956).
50. V. I. Tzalkin, *Materials for the Recognition of the Fauna and Flora of the U.S.S.R.*, published by the Moscow Society of Naturalists, n.s., *Zoological* **27**, 1 (1951).
51. F. Koby, *Bull. soc. prehist. franç.* **51**, 434 (1954); F. E. Zeuner, *Man* **53**, 68 (1953).
52. R. T. Hatt, "The Mammals of Iraq," *Misc. Publ. Museum Zool. Univ. Michigan*, **106**, 1 (1959).
53. M. E. L. Mallowan and J. C. Rose, *Iraq* **2**, 1 (1935).
54. ———, *ibid.* **2**, plate vi(a) (1935).
55. J. W. Amschler, "Report of Scientific Expedition to the Northwest Province of China under the Leadership of Dr. Sven Hedin (The Sino-Swedish Expedition)," *Archives* **4**, 35 (1939).
56. B. Klatt, *Enstehung der Haustiere* (Berlin, 1927).
57. R. Vaufrey, *Mem. arch. inst. paleontol. humaine* **24**, 189 (1951).
58. E. D. Van Buren, *Analecta Orientalia* **18**, 1 (1939).
59. M. Hilzheimer, *Studies Ancient Oriental Civilization* **20**, 1 (1941).
60. M. Burton, *Illustrated London News* **229**, 234 (1956); J. Desmond Clark, personal communication; J. J. Teal, Jr., *Exploration J.* **36**, 13 (1958).
61. C. P. Richter, *Am. J. Human Genet.* **4**, 273 (1952).
62. R. M. Gilmore, *Bull. Bur. Am. Ethnol.* **143**, 345 (1950).
63. J. P. Scott, in *Interrelations between the Social Environment and Psychiatric Disorders* (Milbank Memorial Fund, New York, 1953), pp. 82-102.
64. ———, E. Fredericson, J. L. Fuller, *Personality: Symposia on Topical Issues* **1**, 163 (1951).
65. A. J. Arkell, *Kush* **5**, 8 (1957).
66. V. G. Childe, *The Most Ancient East* (Kegan Paul, Trench, Trubner, London, 1928); M. Wheeler, *Antiquity* **30**, 132 (1956); R. J. Braidwood, *ibid.* **31**, 73 (1957).
67. K. W. Butzer, *Erdkunde* **11**, 21 (1957); *Bonner Geograph. Abhandl.* **24**, 1 (1958).
68. H. Alimen, *The Prehistory of Africa* (Hutchinson, London, 1957).
69. This North African "Neolithic wet period" is to be correlated approximately with the central part of the "Atlantic" period of some authors, the "Hypsithermal" of others. See W. S. Cooper, *Bull. Geol. Soc. Am.* **69**, 941 (1958), for a summary of a confusing terminology.
70. L. Picard, *Bull. Geol. Dept., Hebrew Univ.* **4**, 1 (1943); N. Shalem, *Research Council Israel, Spec. Publ. No. 2* (1953), p. 153; H. E. Wright, Jr., *Studies Ancient Oriental Civilization*, in press; C. A. Reed and R. J. Braidwood, *ibid.*, in press.
71. F. C. Howell, *Proc. Am. Phil. Soc.* **103**, 1 (1959).
72. This article is the third in a series appearing in *Science* on the prehistoric Near East, having been preceded by articles by R. J. Braidwood [**127**, 1419 (1958)] and by Hans Helbaek [**130**, 365 (1959)].
73. The chronological chart was based primarily on *Relative Chronologies in Old World Archeology*, R. W. Ehrich, Ed. (Univ. of Chicago Press, Chicago, Ill., 1954). Radiocarbon dates, to mid-1958, are summarized by R. J. Braidwood [*Osterr. Akad. Wiss. Phil.-Hist. Kl. Anz. Jahrg. 1958* No. 19, 249 (1959.)] Additionally, I had advice from staff members of the Oriental Institute, University of Chicago. Other sources consulted were E. Massoulard (*35*); I. Rizkana, *Bull. inst. du desert* **2**, 117 (1952); and R. P. Charles, *J. Near East. Studies* **16**, 240 (1957).
74. T. Josien, *Israel Explor. J.* **5**, 246 (1955).
75. T. E. Peet, *Mem. Egypt Explor. Fund* **34**, 6 (1914); J. W. Jackson, *Mem. Egypt Explor. Soc.* **42**, 254 (1937).
76. G. Brunton, *Qua and Badari I* (Quaritch, London, 1927); ——— and G. Caton-Thompson, *The Badarian Civilization and Pre-dynastic Remains near Badari* (Quaritch, London, 1928); ———, *Mostagedda and the Tasian Culture* (Quaritch, London, 1937).
77. F. Debono, *Ann. service antiq. Egypte* **48**, 561 (1948); E. A. M. Greiss, *Bull. Inst. Egypte* **36**, 227 (1955).
78. H. Junker, *Anz. Akad. Wiss. Wien., Phil.-Hist. Kl.* **66**, 156 (1930).
79. My acceptance of the presence of five domestic animals for southern Mesopotamia at the beginning of Sumerian culture is based on a number of sources. All five are depicted on cylinder seals of immediately subsequent periods (*37*, *58*), and skeletons of dogs are known [*36*; S. Lloyd, *Illustrated London News* **123**, 303 (1948)].
80. C. Caton-Thompson and E. W. Gardner, *The Desert Fayum* (Royal Anthropological Institute of Great Britain and Ireland, London, 1934), vol. 1, p. 34.
81. M. E. L. Mallowan, *Iraq* **8**, 128 (1946).
82. R. Vaufrey, *Musée Louvre, dept. antiq. orient., ser. Arch.* (1939), vol. v, p. 193. The horn cores Vaufrey assigned to *Ovis vignei* I refer to domestic goats, on the basis of their great similarity to those of domestic goats at Jarmo. The teeth Vaufrey assigned to domestic sheep could belong to these same goats, so the presence of sheep at Sialk remains in doubt.
83. S. Lloyd and F. Safer, *J. Near East. Studies* **4**, 284 (1945). In spite of numerous subsequent statements by different authors concerning the presence of various domestic animals at Hassuna, the original report makes no such claim. However, in view of the geographical location and the chronological position, I believe that domestic dogs and goats, at least, were "probably present."
84. See discussion in text and in *Studies Ancient Oriental Civilization, Univ. Chicago*, in press.
85. C. A. Reed, *Sumer* **10**, 134 (1954). I can state definitely now that there is no evidence to support the preliminary claims, made in 1954, for domestic animals at M'lefaat.

# Basic Research at State Stations

## Twenty-two percent of federal-grant payments to state agricultural experiment stations support basic science.

H. C. Knoblauch

The state agricultural experiment stations, comprising a group of 53 state institutions, are conducting a broad and comprehensive program of research in phases of the life, physical, and social sciences related to agriculture. These stations, generally associated with land-grant colleges or state universities, have a long and successful history of research experience, and many of their findings have blazed new trails in basic fields of science. The federal government, recognizing the important part scientific research could play in solving farm problems, encouraged the establishment of state agricultural experiment stations and a continuing grant-in-aid program through passage of the Hatch Experiment Station Act of 1887. The program was further strengthened by subsequent passage of the Adams Act of 1906, the Purnell Act of 1925, the Bankhead-Jones Act of 1935, and the amendment to the Bankhead-Jones Act of 1946. Each of these provided for further endowment and increases in the federal-grant payments to states. In 1955, the five measures were combined by Congress into the Hatch Act Amended, which serves as the present authorization for grant-in-aid payments to the states.

In terms of the original goals for which the agricultural experiment stations were established, they have gone far beyond the most imaginative concept of their founders. The station system, as developed in the United

The author is director of the State Experiment Stations Division of the Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C.

Table 1. Analysis of federal-grant research by field of research. The percentage of basic research conducted in the various fields varies widely, the applied fields such as farm forestry, agricultural engineering, and agricultural meteorology all having less than 10 percent. The relative scope of the program in any one field may be determined by the total expenditures and the number of projects in that field.

| Field | Projects | | Expenditures | | | |
|---|---|---|---|---|---|---|
| | No. | Percent of total | Amount ($) | Percent of total | For basic research ($) | Percentage basic research |
| 1. Forestry | 91 | 1.7 | 309,033 | 1.2 | 19,179 | 6.2 |
| 2. Agricultural engineering | 243 | 4.6 | 1,263,363 | 4.9 | 101,982 | 8.1 |
| 3. Meteorology | 27 | 0.5 | 120,661 | 0.5 | 11,505 | 9.5 |
| 4. Agricultural economics | 310 | 5.8 | 1,370,372 | 5.3 | 213,342 | 15.6 |
| 5. Veterinary science | 232 | 4.4 | 1,343,568 | 5.2 | 234,883 | 17.5 |
| 6. Horticulture | 435 | 8.2 | 1,582,106 | 6.1 | 288,256 | 18.2 |
| 7. Agronomy | 629 | 11.9 | 3,097,789 | 12.0 | 575,713 | 18.6 |
| 8. Dairy husbandry | 187 | 3.5 | 1,176,892 | 4.6 | 226,857 | 19.3 |
| 9. Animal husbandry | 382 | 7.2 | 2,319,659 | 9.0 | 450,236 | 19.4 |
| 10. Entomology and zoology | 380 | 7.2 | 1,523,417 | 5.9 | 323,550 | 21.2 |
| 11. Marketing | 505 | 9.5 | 2,766,526 | 10.8 | 630,965 | 22.8 |
| 12. Soils | 396 | 7.5 | 1,848,671 | 7.2 | 441,184 | 23.9 |
| 13. Food technology | 228 | 4.3 | 1,155,924 | 4.5 | 292,444 | 25.3 |
| 14. Human nutrition and home economics | 249 | 4.7 | 1,333,851 | 5.2 | 351,623 | 26.4 |
| 15. Rural life studies | 106 | 2.0 | 448,745 | 1.7 | 120,781 | 26.9 |
| 16. Poultry husbandry | 251 | 4.7 | 1,120,068 | 4.3 | 303,633 | 27.1 |
| 17. Botany and plant pathology | 626 | 11.8 | 2,884,115 | 11.2 | 1,102,322 | 38.2 |
| 18. Agricultural chemistry | 25 | 0.5 | 91,204 | 0.4 | 42,791 | 46.9 |
| Total | 5302 | 100.0 | 25,755,964 | 100.0 | 5,731,246 | |

States, has made tremendous contributions to science. Many of these have benefited not only agriculture but all mankind. Discoveries like streptomycin and Dicumarol, for example, while growing out of agricultural experiment station research, have advanced scientific progress in medicine.

The agricultural experiment stations provide a scientific service on many fronts. They pioneer in fields of study the usefulness of which may not be immediately apparent, but which may contribute to a broad advancement of knowledge. No matter how simple the problem brought to an experiment station may appear, the scientific finding of the answer often requires considerable basic research.

The federal government's research grants made to state experiment stations under the Hatch Act have for years served as incentives to the states to appropriate additional funds and to individuals and organizations to make private grants. Both federal and state monies can and should be used increasingly for problems requiring basic research. During fiscal year 1957, approximately 25 percent of the total support for research at the state agricultural experiment stations was derived from federal-grant payments under the amended Hatch Act. Both the state agricultural experiment stations, which administer and conduct the research under these funds, and the State Experiment Stations Division of the Agricultural Research Service, which administers the federal-grant program, have placed increasing emphasis on research aimed at basic problems in agriculture.

Surveys made during recent years indicate that the agricultural experiment stations devote a substantial amount of their resources to such research. In 1953–54, the National Science Foundation made a survey on the amount of funds used for basic research by the 53 agricultural experiment stations. The report, issued in 1957, showed expenditures for basic research as follows: 23 percent in the life sciences; 35 percent in the physical sciences; and 16 percent in the social sciences. The average total for experiment station funds for basic research was 23 percent of the total money available. The other 77 percent was reported to be earmarked for applied research—including a small amount for development (*1*).

A recent report on basic research in industry indicated that counting abstracts published by various industries gave a measure of the industry's effort in basic research (*2*).

Since 1951, the Department of Agriculture has reported annually to the Bureau of the Budget and to the National Science Foundation the estimated percentage of federal-grant funds going into basic and applied research and development.

Percentage figures may, of course, vary considerably, according to the definition of basic research used. To lend greater accuracy to the estimates of basic research performed with federal-grant funds, an analysis was made in 1958, on the basis of the definition developed by the National Science Foundation (*3*).

Table 2. Analysis of federal-grant research by major areas of research. This table combines the data given in Table 1 into five major areas, as follows: *Animal science*: animal husbandry, dairy husbandry, poultry husbandry, and veterinary science. *Economics and marketing, and related social sciences*: agricultural economics, marketing, and rural sociology. *Physical sciences*: agricultural chemistry, agricultural engineering, and meteorology. *Plant science*: entomology, field crops, forage crops, forestry, fruits and nuts, ornamental and drug plants, plant pathology, plant physiology, soils, vegetables, and weeds. *Utilization and home economics*: dairy technology, food science and technology, and home economics.

| Area | Projects | | Expenditures | | | |
|---|---|---|---|---|---|---|
| | No. | Percent of total | Amount ($) | Percent of total | For basic research ($) | Percentage basic research |
| Physical science | 295 | 5.6 | 1,475,228 | 5.7 | 156,278 | 10.6 |
| Utilization and home economics | 477 | 9.0 | 2,489,775 | 9.7 | 644,067 | 25.9 |
| Economics and marketing | 921 | 17.4 | 4,585,643 | 17.8 | 965,088 | 21.0 |
| Animal science | 1052 | 19.8 | 5,960,187 | 23.1 | 1,215,609 | 20.4 |
| Plant science | 2557 | 48.2 | 11,245,131 | 43.7 | 2,750,204 | 24.5 |
| Total | 5302 | 100.0 | $25,755,964 | 100.0 | $5,731,246 | |

## Analytical Study

Each of the 5302 federal-grant research projects in the files of the State Experiment Stations Division was studied. The study was undertaken by

33 specialists in the division, and in many cases two or more specialists made appraisals of specific projects and reports of progress in determining the amount of basic research involved.

### Results

Figure 1 and Tables 1 and 2 present the results obtained from the analysis. The average for all stations for basic research was 22.3 percent, the range for the stations being from 3.2 to 46.1 percent. The relative ranking of each state is considered reliable, representing a composite rating of all fields by the several scientists who took part in the study.

It should be noted that the federal grants compose from less than 10 percent of the total funds available in some state stations to over 65 percent in others. A rather strong correlation exists between the level of nonfederal fund support and the amount of basic research supported by the federal-grant funds.

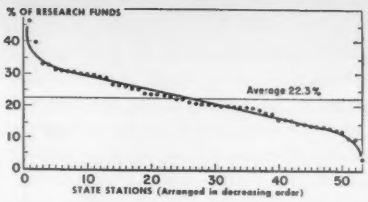



Fig. 1. Basic research in agriculture for fiscal year 1957 at the 53 state agricultural experiment stations, as estimated from an analysis of projects receiving federal-grant support. [U.S. Agricultural Research Service]

The sample of 5302 federal-grant experiment station projects can be considered representative of the total program of state station research, which, in 1957, involved an additional 6500 projects supported by state-appropriated and other funds. The total expenditures from federal-grant and nonfederal funds in 1957 were approximately $114 million. By applying the percentage figure obtained for basic research for projects supported by federal-grant funds to the total, it was found that the experiment stations used over $25 million of the funds available during the 1957 fiscal year for basic research (*4*).

#### References and Notes


1. "Funds for Research in Agricultural Experiment Stations, 1953–54," National Science Foundation, Reviews of Data on Research & Development, No. 8 (*NSF 57–37*, Nov. 1957).
2. J. C. Fisher, *Science* **129**, 1653 (1959).
3. "Basic research is that type of research which is directed toward increase of knowledge in science. It is research where the primary aim of the investigator is a fuller knowledge or understanding of the subject under study rather than a practical application thereof." (From a letter written by Alan T. Waterman, director of the National Science Foundation, to B. T. Shaw, administrator of the Agricultural Research Service, 22 Nov. 1957).
4. This article is an analysis of research undertaken at the state agricultural experiment stations with federal-grant support. It is adapted from an address presented before the Experiment Station Section of the American Association of Land-Grant Colleges and State Universities in Washington, D.C., 11 Nov. 1958.


# Science in the News

## Antarctic Treaty Signed by IGY Nations: Polar Region Established as Neutral Science Reserve

The United States and 11 other nations signed a treaty in Washington on 1 December which provides that Antarctica shall be used for peaceful purposes only and that the international scientific cooperation which characterized the 1957–58 International Geophysical Year shall continue. This is the first treaty in history to prohibit military operations and all forms of nuclear explosion in an entire continent, in this case an area of 5 million square miles, equal in size to the United States and Europe combined. This is also the first time that the Soviet Union has agreed to unrestricted inspection of an area as a guarantee of the enforcement of demilitarization provisions.

The importance of the treaty lies not only in what it covers but in what it implies. Many observers feel that it could set a precedent for an agreement about the use of outer space and for dealing with uninhabited and desert regions, including, for example, the moon. Newspaper editorials have pointed out that it might also set a precedent that would result in an easing of the U.S.S.R.'s concern about inspection of its lands in a disarmament arrangement.

#### Territorial Provisions and Membership

The treaty provides that all territorial and sovereignty claims, and the position of all governments regarding the recognition or nonrecognition of such claims, shall remain in *status quo* for the duration of the treaty. Seven of the 12 participants maintain that sections of Antarctica are parts of their homelands, and several of these claims overlap (see map on page 1643).

It was only a few years ago, in 1947–48, that Argentina and Chile were in bitter dispute with Britain over territorial rights in the Palmer Peninsula. Argentine and British naval vessels were even dispatched to the region. It was this crisis that led to an unsuccessful proposal by the United States in 1948 for an international agreement. Neither the United States nor the U.S.S.R. has attempted to establish claims in the Antarctic.

The new treaty is of indefinite duration, but after 30 years any party may call a conference for review and amendment. The pact is open to accession by other United Nations members and by such other states as may be agreed upon unanimously.

Thus, Communist China probably could not join, as it is not a U.N. member and its application for membership would probably be vetoed. But that would not prevent the Communist Chinese from sending a scientific expedition to the Antarctic if their intentions were peaceful. Of course, the treaty members would watch any such expedition carefully.

### IGY Sets the Stage

It was the very successful cooperative scientific activities of the IGY that set the stage for the pact. With the increase in the number of expeditions to the Antarctic, the nearest overseas neighbors—particularly Chile, New Zealand, South Africa, and Australia—became increasingly disturbed about the possible establishment of threatening military bases. Furthermore, they were worried about the use of the region for nuclear tests and waste disposal. Weather conditions in these countries originate in Antarctica, and there has been a growing fear, especially in South America, that winds might carry radioactive materials.

The treaty provisions against nuclear testing were not introduced until quite late in the negotiations. Many observers feel that the inclusion of these provisions will help bring about speedy ratification of the treaty by the Latin American countries in which Antarctic affairs have constituted such a tense political issue.

### Treaty Evolution and Operation

The conference called to negotiate the treaty was convened at the suggestion of the United States. On 3 May 1958 President Eisenhower announced that invitations had been extended to the governments of the 11 nations that had carried on scientific research programs in Antarctica during the International Geophysical Year to participate in a conference with a view to writing a treaty "dedicated to the principle that the vast uninhabited wastes of Antarctica shall be used only for peaceful purposes." The following nations were invited: Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, the Union of South Africa, the U.S.S.R., and the United Kingdom.

The treaty, the result of 15 months of preparatory talks and 7 weeks of formal negotiation, will not go into effect until it has been ratified by the 12 governments. In the United States, the instrument of ratification is issued by the President after a resolution of approval is agreed to by a two-thirds vote of the Senate.

In order to further the purposes and the objectives of the treaty, a consultative committee will be established and will meet within 2 months of the date on which the treaty becomes effective, and at suitable intervals thereafter, to recommend measures to the participating parties. The first meeting will be held in Canberra, Australia. In the meantime, the conference recommended that representatives of the governments meet in Washington at convenient times to discuss such arrangements as seem desirable.

The Conference on Antarctica convened in Washington on 15 October. At the first plenary session, held that day, Ambassador Herman Phleger, the U.S. representative, was named chairman of the conference, and Henry E. Allen was named secretary-general. Ambassador Paul C. Daniels and George H. Owen served as alternate U.S. representatives. It is reported that Daniels has, for a year and a half, carried out, quietly and anonymously, the negotiation that led to the conference.

### The United States in Antarctica

The United States' interest in Antarctica dates from the early part of the 19th century. One of the earliest achievements was the 1838–42 expedition of Lieutenant Charles Wilkes, which made sightings extending for 1500 miles, thus proving the existence of the antarctic continent.

The period from 1928 to the present has been one of great activity in Antarctica, chiefly because of the work of such men as Rear Admiral Richard E. Byrd, Lincoln Ellsworth, Captain Finn Ronne, and Rear Admiral R. H. Cruzen. The U.S. Navy in 1946–47 organized the largest of the expeditions to Antarctica. During the International

U.S. delegation to the conference on Antarctia. Larkin H. Farinholt (deputy science adviser, Department of State) adviser; Milan W. Jerabek, adviser; Alton W. Hemba, adviser; Ambassador Herman Phleger, U.S. representative; Alan F. Neidle, adviser; Henry C. Reed, adviser; Ambassador Paul C. Daniels, alternate U.S. representative; Arthur H. Rosen, adviser; Captain Eugene W. Davis, U.S.N., adviser; George H. Owen, alternate U.S. representative; Wayne W. Fisher, secretary; and Robert M. Schneider, adviser.

Geophysical Year the United States established seven stations in Antarctica under the leadership of Rear Admiral George Dufek. At the present time four stations are being maintained, including one at the South Pole.

The Soviet Union also has four scientific bases. Altogether, the 12 treaty nations operate 58 stations in the antarctic region.

United States research in Antarctica is coordinated and planned by the National Science Foundation. Thomas O. Jones heads the foundation program, which is made possible through the logistic support of the Navy Department. The U.S. Naval Support Force is commanded by Rear Admiral David N. Tyree.

### The Treaty

*The preamble and some of the more significant provisions of the 14-article treaty appear below.*

The [12] Governments . . . recognizing that it is in the interest of all mankind that Antarctica shall continue forever to be used exclusively for peaceful purposes and shall not become the scene or object of international discord;

Acknowledging the substantial contributions to scientific knowledge resulting from international cooperation in scientific investigation in Antarctica;

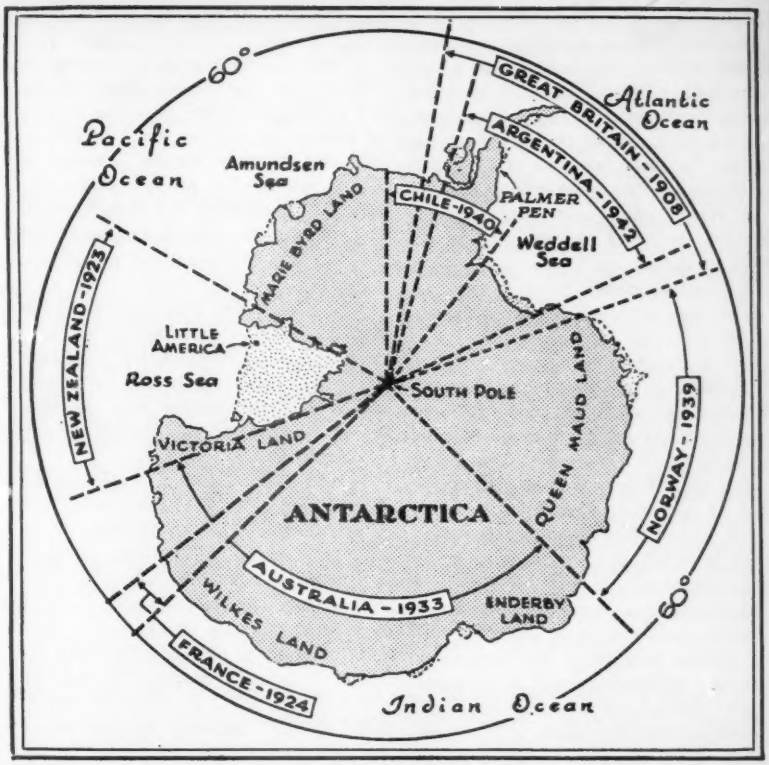
Convinced that the establishment of a firm foundation for the continuation and development of such cooperation on the basis of freedom of scientific investigation in Antarctica as applied during the International Geophysical Year accords with the interest of science and the progress of all mankind;

Convinced also that a treaty ensuring the use of Antarctica for peaceful purposes only and the continuance of international harmony in Antarctica will further the purposes and principles embodied in the Charter of the United Nations;

Have agreed as follows:

*Article I.* 1. Antartica shall be used for peaceful purposes only. There shall be prohibited, *inter alia,* any measures of a military nature, such as the establishment of military bases and fortifications, the carrying out of military maneuvers, as well as the testing of any type of weapons.

2. The present Treaty shall not prevent the use of military personnel or equipment for scientific research or for any other peaceful purpose.




Territorial claims in the Antarctic.

*Article II.* Freedom of scientific investigation in Antarctica and cooperation toward that end, as applied during the International Geophysical Year, shall continue, subject to the provisions of the present Treaty.

*Article III.* 1. In order to promote international cooperation in scientific investigation in Antarctica the Contracting Parties agree that, to the greatest extent feasible and practicable:

(a) information regarding plans for scientific programs in Antarctica shall be exchanged to permit maximum economy and efficiency of operations;

(b) scientific personnel shall be exchanged in Antarctica between expeditions and stations;

(c) scientific observations and results from Antarctica shall be exchanged and made freely available.

2. In implementing this Article, every encouragement shall be given to the establishment of cooperative working relations with those Specialized Agencies of the United Nations and other international organizations having a scientific or technical interest in Antarctica. . . .

*Article V.* 1. Any nuclear explosions in Antarctica and the disposal there of radioactive waste material shall be prohibited.

2. In the event of the conclusion of international agreements concerning the use of nuclear energy, including nuclear explosions and the disposal of radioactive waste material, to which all of the Contracting Parties whose representatives are entitled to participate in the meetings provided for under Article IX are parties, the rules established under such agreements shall apply in Antarctica. . . .

*Article VI.* The provisions of the present Treaty shall apply to the area south of 60° South Latitude, including all ice shelves, but nothing in the present Treaty shall prejudice or in any way affect the rights, or the exercise of the rights, of any State under international law with regard to the high seas within that area.

*Article VII.* 1. Each Contracting Party shall have the right to designate observers to carry out any inspection provided for by the present Article. Observers shall be nationals of the Contracting Parties which designate them.

2. Each observer shall have com-

plete freedom of access at any time to any or all areas of Antarctica.

3. All areas of Antarctica, including all stations, installations and equipment within those areas, and all ships and aircraft at points of discharging or embarking cargoes or personnel in Antarctica, shall be open at all times to inspection by any observers. . . .

4. Aerial observation may be carried out at any time over any or all areas of Antarctica. . . .

5. Each Contracting Party shall . . . inform the other Contracting Parties . . . of

(a) all expeditions to and within Antarctica, on the part of its ships or nationals, and all expeditions to Antarctica organized in or proceeding from its territory;

(b) all stations in Antarctica occupied by its nationals; and

(c) any military personnel or equipment intended to be introduced by it into Antarctica. . . .

*Article XI.* 1. If any dispute arises between two or more of the Contracting Parties concerning the interpretation or application of the present Treaty, those Contracting Parties shall consult among themselves with a view to having the dispute resolved by negotiation, inquiry, mediation, conciliation, arbitration, judicial settlement or other peaceful means of their own choice.

2. Any dispute of this character not so resolved shall, with the consent, in each case, of all parties to the dispute, be referred to the International Court of Justice for settlement; but failure to reach agreement on reference to the International Court shall not absolve parties to the dispute from the responsibility of continuing to seek to resolve it by any of the various peaceful means referred to in paragraph 1 of this Article.

*Article XII.* 1. (a) The present Treaty may be modified or amended at any time by unanimous agreement of the Contracting Parties. . . . Any such modification or amendment shall enter into force when the depositary Government has received notice from all such Contracting Parties that they have ratified it. . . .

*Article XIII.* 1. The present Treaty shall be subject to ratification by the signatory States. It shall be open for accession by any State which is a Member of the United Nations, or by any other State which may be invited to accede to the Treaty with the consent of all the Contracting Parties. . . .

## Minneapolis Newsman, "Fortune" Editor, Win Science Writing Awards

Victor Cohn, science writer for the Minneapolis *Tribune*, and Francis Bello, a member of *Fortune* magazine's board of editors, will receive the AAAS-Westinghouse Science Writing Awards of $1000 each. The prizes will be presented 27 December at a dinner in Chicago during the annual meeting of the AAAS, which administers the annual awards.

The judges also selected three additional science writers to receive honorable mention citations for excellence in science reporting in the newspaper field. An equal number were awarded honorable mention for science writing in magazines.

William Hines, science writer for the Washington (D.C.) *Evening Star*, Earl Ubell, science editor of the New York *Herald Tribune*, and Doug Walker, writer for the Dayton (Ohio) *Journal Herald*, received the honorable mention newspaper citations. Winners of honorable mention in the magazine field included James R. Newman, member of the editorial board of *Scientific American*; Walter Sullivan, science writer for the New York *Times*; and Georg Zappler, a graduate student in zoology at Columbia University.

### News Winner

Cohn won his award for a series of articles on the state of Russian science entitled, "Year of the Sputnik," which appeared in the Minneapolis *Tribune* 6–22 October 1958. His series, written after a 5-week tour of Russian facilities for physical research, analyzed and reported on the recent upsurge of Russian science and technology.

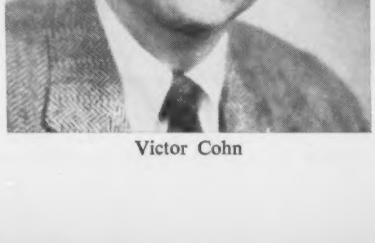
"The Year of the First Sputnik has ended," he wrote, "and in that year the Russians have advanced more in science than we. . . . Russia will lead the United States in most important fields of science—not just space or Sputniks—in 10 years, in the opinion of many informed Americans." His articles then describe various scientific and technological fields in which the Soviets are making major advances.

Born in Minneapolis in 1919, Cohn attended South High School there and in 1941 graduated from the University of Minnesota. After brief service on the picture desk of the Minneapolis *Star*, he served in the U.S. Navy from 1942 to 1945.

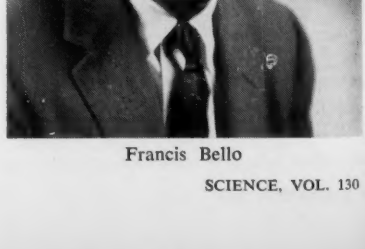
Returning to civilian life, Cohn became a copyreader, then a science reporter for the *Tribune*, and he has held this position ever since. He is secretary-treasurer of the National Association of Science Writers. Cohn and his family live in Minneapolis.

### Magazine Winner

Francis Bello's prize-winning article, "An Astonishing New Theory of Color," which appeared in the May 1959 issue of *Fortune*, describes in graphic detail a new theory about the way the human eye sees color. The new theory is the result of the experimental work of Edwin H. Land, founder and head of the Polaroid Corporation. Bello contrasts the new theory with the commonly accepted one based on the early work of Sir Isaac Newton three centuries ago. For all this time, Bello's article points out, we may have been com-



Victor Cohn



Francis Bello

pletely fooled in our explanation of human color vision.

Bello was born in Newark, N.J., in 1917. He majored in chemistry at Drew University, from which he received his A.B. degree in 1939. He joined the *Fortune* staff in 1941 as a researcher. He left to serve for several years in the Air Force, then returned to *Fortune* as a staff writer. In December 1949 he was appointed an associate editor, and in April of this year he became a member of the board of editors. Bello and his wife and two sons live in South Orange, N.J.

#### Honorable Mention Winners

Hines won honorable mention in newspaper writing for a six-part report on Project Mercury's man-in-space program, entitled "The Astronaut Story," which appeared in the *Evening Star* in July. Ubell received recognition for a five-part series which appeared in May in the *Herald Tribune*. Entitled "The Institute For Advanced Study," it described the work of this select group of scientists at Princeton University. Walker won recognition for a December 1958 series of five articles in the *Journal Herald*, entitled "A Journey Into Space."

In the magazine field, Newman received honorable mention for "Einstein's Great Idea," which appeared in the 16 May issue of the *Saturday Evening Post* as one of the "Adventures of the Mind" series. The other two articles cited for honorable mention appeared in *Natural History*, a publication of the American Museum of Natural History. Sullivan's article, "Geophysical Year Ends," was published in January, while Zappler's article on "Darwin's Worms" appeared in November 1958.

#### Judges

A panel of eminent representatives from the fields of journalism, science, and education selected the winners. The judges were Earl English, dean of the school of journalism at the University of Missouri; Caryl Haskins, president of the Carnegie Institution of Washington; James Linen, publisher of *Time*; Morris Meister, president of Bronx Community College; Alan Waterman, director of the National Science Foundation; and James Wiggins, executive editor of the *Washington Post and Times Herald* and president of the American Society of Newspaper Editors.

The AAAS-Westinghouse Science Writing Awards were established to give recognition and encouragement to outstanding science writing, to stimulate public interest in science, and to foster a deeper understanding of science by the general public. The awards are made possible by a grant from the Westinghouse Educational Foundation.

---

### United States and Soviet Union Sign Exchange Pact

The United States and the U.S.S.R. have signed an agreement on cooperation in exchanges in the fields of science, technology, education, and culture in 1960–61. The agreement was signed in Moscow on 21 November after about 2 weeks of negotiation. It is based on discussions that took place between President Eisenhower and Premier Khrushchev on the occasion of the latter's visit to the United States. During the negotiations both delegations noted with satisfaction the fulfillment of the previous 2-year exchange agreement.

The new agreement, which goes into force on 1 January, provides for a concrete 2-year program of exchanges in the fields of education (including student exchanges), science, public health, agriculture, industry, transport, construction, and trade. Provision is also made for exchanges in the various fields of the performing arts, for cooperation in the motion-picture field, and for exchanges of radio and television programs and of publications and exhibits. In addition, the two countries have agreed to "render assistance" in arranging for visits by representatives of public organizations and groups, exchanges of athletes, development of tourism, and establishment of direct air communication. The pact included as an addendum the text of the Memorandum on Cooperation in the Field of the Utilization of Atomic Energy for Peaceful Purposes, which was signed in Washington, D.C., on 20 November.

#### Britain Signs Similar Pact

On 1 December Britain and the U.S.S.R. signed a similar document, the first cultural agreement with the Soviet Union that the British Government has signed. Such cultural agreements as have been concluded between the two countries in the past have been between unofficial bodies. Britain's pact will be effective for 1 year, beginning in April. Abstracts from this country's new agreement with the Soviet Union will appear in the next issue of *Science*.

### News Briefs

The program of the First International Congress of Endocrinology, which will be held in Copenhagen, Denmark, 18–23 July 1960, will consist of ten symposia, a round-table discussion, and sessions for papers. The speakers at the symposia and the round-table discussion have been invited. Investigators interested in presenting papers to the communicated sessions are reminded that abstract forms for such papers must be secured from the Congress Secretariat, Statens Seruminstitut, Copenhagen S, Denmark, and that these abstracts must be submitted by 31 December 1959.

* * *

The Alfred E. Cohn Library at the Rockefeller Institute was dedicated on 3 December. The special exercises included a memorial service in honor of the late Alfred Einstein Cohn, cardiologist and former member of the institute, who died in 1957. Cohn was among the first to make electrocardiograms in this country.

* * *

The Eugene F. DuBois Library was dedicated 24 November by the staff of the Second (Cornell) Medical Division, Bellevue Hospital, New York. The library occupies the exact site of DuBois' pioneer research in human metabolism, begun at Bellevue in 1911.

* * *

The Commonwealth Fund, New York, recently issued an annual report that announces the award of grants totaling $3,803,325 in fiscal year 1958–59. About 84 percent of the amount appropriated was directed toward the general area of health. Medical education and community health activities received grants of $1,353,993; medical research, grants of $990,959. Fellowships and other awards in the health field totaled $848,923. Providing support for the medical schools of the country is the chief activity of the fund at the present time.

* * *

*Rocket Club*, a public-service film made with the cooperation of the U.S. Air Force, was shown for the first time in Washington, D.C., on 9 December. The 15-minute color film, which emphasizes the organization of local rocket clubs for young experimenters in the missile and rocket sciences, is designed for use by educator, parent, church, and youth groups. Free prints of *Rocket Club*, for showing to adult-supervised groups of 15 or more, may

be obtained by writing to: Training Service Department, Daisy Manufacturing Company, Rogers, Ark.

* * *

For 10 years the American Trust Company of San Francisco has supported a weekly television program, "Science in Action," that is produced by the California Academy of Sciences. The show, which has won many awards, presents science at the family-audience level. The sponsor has been honored repeatedly for this public service. It is notable that the bank first sponsored the science show in 1950, considerably before science became part of the daily news.

* * *

The Endocrinology Study Section, National Institutes of Health, has the following highly purified pituitary hormones available for distribution free to qualified investigators: growth hormone—bovine, nonsterile, for animal experiments only; follicle-stimulating hormone, ovine, sterile preparation; luteinizing hormone, ovine, sterile preparation; and prolactin, ovine, sterile preparation. These hormones may be obtained from Dr. R. T. Hill, Executive Secretary, Endocrinology Study Section, Division of Research Grants, National Institutes of Health, Bethesda 14, Md. Applicants should describe briefly the proposed work and give an estimate of the amount of hormone required.

## Grants, Fellowships, and Awards

**Antarctic.** The National Science Foundation has announced that final proposals for antarctic research for the 1960–61 field season should be submitted by *15 February 1960*. Proposals should be addressed to the Director, National Science Foundation, Washington 25, D.C., Attention: Antarctic Program Director.

Proposals will be accepted for research on aurora and airglow, biology and medical sciences, cosmic rays, geodesy and cartography, geology, geomagnetism, glaciology, gravity, ionospheric physics, meteorology, oceanography, and seismology, and for such other research as may be pertinent to Antarctica. The staff of the Antarctic Research Program of the NSF will be glad to discuss ideas for proposals informally prior to their final submission or to answer questions regarding the preparation of proposals and problems of research in the antarctic.

**Atomic industrial medicine.** The U.S. Atomic Energy Commission has announced its next year's program of special fellowships in industrial medicine, which are administered by the Atomic Energy Project, School of Medicine and Dentistry, University of Rochester. The fellowships provide advanced training and on-the-job experience, particularly in relation to the atomic energy industry. The selection of fellows is made by the AEC, which has eight awards available for the period 1960–61.

The fellowships are open to physicians, both men and women, who are citizens of the United States, who graduated from an approved college of medicine at least 2 years prior to the date on which their tenure would commence, and who are licensed to practice medicine in one of the states or territories of the United States. A successful candidate will be required to have a full F.B.I. investigation and be cleared by the commission before being awarded a fellowship.

The training program consists of two parts: an academic year, with lecture and laboratory instruction in the practice of industrial medicine, and an in-plant training year, in which the fellow will be assigned to one or more of the medical departments of the major operating plants and laboratories under the direction of the Atomic Energy Commission. The stipend for an academic year is $5000. For a wife, $350 is added to the total stipend, and $350 more is added for each dependent child. Tuition and laboratory fees for academic courses will be paid by the commission. Certain other expenses incident to the work of the fellow will be paid when these are approved by the fellowship committee.

Applications should be filed before *1 January 1960*. It is expected that the selection of fellows will be made on or before 1 February 1960, but fellowships may be assigned at any time at the discretion of the committee. Address all inquiries to: Dr. Henry A. Blair, AEC Fellowships in Industrial Medicine, Atomic Energy Project, University of Rochester, School of Medicine and Dentistry, Rochester 20, New York.

**Geology.** The American Association of Petroleum Geologists has again made a fund available for grants-in-aid for support of research in fields of general interest to the petroleum geologist. Applications will be received until *1 January 1960*. The awards are open to anyone working, within the United States, on research projects that are of interest to petroleum geologists. As in past years, the Subcommittee on Grants-in-Aid will use the survey "Research Needs in Petroleum Geology" [*Bull. Am. Assoc. Petrol. Geologists* **41**, 1854 (1957)] as a general guide in making recommendations for support of research projects. Detailed information and application forms may be obtained from A.A.P.G. Headquarters, Box 979, Tulsa, Okla.

**Travel.** Limited funds are available from the National Science Foundation for the support of travel by American scientists to international scientific congresses. An attempt will be made to have the grants approximate round-trip air-tourist fare between the recipient's home institution and the place of meeting. The following congresses have been selected for support. To obtain application forms, write to the indicated division of the National Science Foundation, Washington 25, D.C., or to any alternate address given.

International Congress on Microwave Tubes, in Munich, Germany, 7–11 June 1960. Application forms available from: Division of Mathematical, Physical, and Engineering Sciences. Closing date: *31 March 1960*.

First Congress of International Federation of Automatic Control, in Moscow, U.S.S.R., 25 June–9 July 1960. Application forms available from: Division of Mathematical, Physical, and Engineering Sciences. Closing date: *31 March 1960*.

Second International Congress on Catalysis, in Paris, France, 4–9 July 1960. Application forms available from: Division of Mathematical, Physical, and Engineering Sciences or from Petroleum Research Fund, American Chemical Society, 1155 16th St., NW, Washington 6, D.C. Closing date: *1 January 1960*.

Second World Congress on Earthquake Engineering, in Tokyo and Kyoto, Japan, 11–18 July 1960. Application forms available from: Division of Mathematical, Physical, and Engineering Sciences. Closing date: *30 April 1960*.

Eighth International Grassland Congress, in Reading, England, 11–21 July 1960. Application forms available from: Division of Biological and Medical Sciences. Closing date: *1 February 1960*.

Sixteenth International Congress on

Psychology, in Bonn, Germany, 31 July–6 August 1960. Application forms available from: Division of Biological and Medical Sciences. Closing date: *15 February 1960.*

Sixth International Congress of Anthropological and Ethnological Sciences, in Paris, France, 31 July–7 August 1960. Application forms available from: Office of Social Sciences. Closing date: *1 February 1960.*

International Geographical Congress, in Stockholm, 6–13 August 1960. Application forms available from: Division of Mathematical, Physical, and Engineering Sciences. Closing date: *1 February 1960.*

International Congress of Entomology, in Vienna, Austria, 17–25 August 1960. Application forms available from: R. N. Nelson, Executive Secretary, Entomological Society of America, 1530 P St., NW, Washington 6, D.C. Closing date: *15 January 1960.*

## Scientists in the News

On 16 December the Franklin Institute, Philadelphia, will pay tribute to **F. G. Swann**, director emeritus of the Bartol Research Foundation, for his long years of distinguished service to the institute. Swann, who served as the first director of the Bartol Foundation from 1927 until his retirement on 31 August of this year, will be the speaker of the evening and will discuss "The Science of Yesterday, Today and Tomorrow." He will also be the guest of honor at a reception preceding a dinner.

**Sir Richard V. Southwell**, former rector of the Imperial College, London, England, has received the Timoshenko Medal of the American Society of Mechanical Engineers for "teaching and research in the application of mathematical and numerical techniques to the solution of practical problems in engineering science."

The society has also honored **Stephen J. Kline**, associate professor of mechanical engineering at Stanford University. He received the Melville Prize Medal for his paper "On the Nature of Stall."

**Detlev W. Bronk**, president of the Rockefeller Institute, has received a special medal from the Society for Promoting International Scientific Relationships. Bronk, who is also president of the National Academy of Sciences, was honored for his accomplishments in fostering the promotion of scientific research and international cooperation through exchanges of scholars. The presentation took place on 24 November. The principal address, on "Science and the Progress of Man," was delivered by Alan T. Waterman, director of the National Science Foundation.

The Society for Promoting International Scientific Relationships is comprised principally of chemists, biochemists and physicists. It has approximately 500 members, and corresponding members in many countries.

**Eugene B. Brody** has been named chairman of the department of psychiatry and director of the Psychiatric Institute of the University of Maryland School of Medicine (Baltimore). Brody joined the Maryland faculty in 1957 as professor of psychiatry and was appointed psychiatrist-in-chief to University Hospital and the Psychiatric Institute in 1958. Since the death of Jacob E. Finesinger in June of this year, he has been acting chairman of the department and acting director of the institute.

**Harry Ferguson**, mathematician and research engineer at the Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio, has been appointed associate professor of mathematics in the University of Cincinnati's College of Engineering.

**Seymour Perlin** has been appointed chief of the newly established division of psychiatry at Montefiore Hospital, New York. Perlin, currently a fellow at the Center for Advanced Studies in the Behavioral Sciences, Stanford, Calif., has resigned his position as chief of the section of psychiatry in the Laboratory of Clinical Science, National Institute of Mental Health.

**Perry Johnston**, professor of zoology at the University of Arkansas, has joined the Atomic Energy Commission's Division of Biology and Medicine, Germantown, Md., where he is a biologist (histology) in the medical branch.

An award for outstanding achievement in research contributing to the advancement of forestry was made to **Francis X. Schumacher** of the Duke University School of Forestry at the recent annual meeting of the Society of American Foresters held in San Francisco. A specialist in forest biometry, Schumacher is internationally recognized for his pioneer work in the application of statistics to silviculture.

**Arthur E. Lilley**, radio astronomer and an assistant professor at Yale University, will join the Harvard University faculty on 1 January as associate professor of astronomy. This fall he has been visiting lecturer at Harvard.

**Erik H. Erikson**, senior psychoanalyst at the Austen Riggs Center, Stockbridge, Mass., will become professor of human development and lecturer in psychiatry at Harvard University effective 1 July.

## Recent Deaths

**Gladwyn Graham**, Philadelphia, Pa.; 57; chief of the oral surgery department at the University of Pennsylvania Hospital; 17 Nov.

**Godfrey R. Hoerner**, Corvallis, Ore.; 66; plant pathologist and chief of the Oregon State College technical assistance team at Kasetsart University, Thailand; 23 Oct.

**Sara M. Jordan**, Marblehead, Mass.; 75; surgeon and gastroenterologist; cofounder of the Lahey Clinic, Boston; 21 Nov.

**Albert R. Lamb**, Pine Orchard, Conn.; 78; emeritus professor of clinical medicine at Columbia University; 22 Nov.

**Walter H. Moursand, Jr.**, Washington, D.C.; 50; chief of Army Physical Standards in the office of the Surgeon General, Department of the Army, Washington; 20 Nov.

**Arthur L. Rawlings**, New York, N.Y.; 78; chief engineer for research of the Bulova Research and Development Laboratories, Queens, N.Y.; inventor of gyroscopic mechanisms; 17 Nov.

**Edward C. Tolman**, Berkeley, Calif.; 73; emeritus professor of psychology at the University of California, Berkeley; author of *Purposive Behavior of Animals and Man* and *Drives toward War*; 19 Nov.

**Vernon C. Turner**, Evanston, Ill.; 52; associate professor of orthopedic surgery at the Northwestern University Medical School; chairman of the department of orthopedics at Evanston Hospital; 21 Nov.

# Book Reviews

**The Soviet Citizen.** Daily life in a totalitarian society. Alex Inkeles and Raymond A. Bauer. Harvard University Press, Cambridge, Mass., 1959. xx + 533 pp. $10.

This book is testimony to the skill of social scientists; yet if social science were everywhere as competent and as free as we should like it to be, there would have been no need to write the book.

By 1950 it had become amply apparent that we knew very little about one of the most powerful industrial societies in the world, and especially about how it worked as a social system and about public and private opinion within it. Furthermore, it had become clear that Stalin was not interested in letting any information of these kinds leak out. For this reason the Harvard project on the Soviet social system was formed; it was financed by the U.S. Air Force to the extent of approximately $1 million. Clyde Kluckhohn, the anthropologist, was general director of the project, and Alex Inkeles and Raymond Bauer, sociologist and psychologist, respectively, were director and codirector of research.

In 1950 there was only one large source of relatively untapped information on the Soviet social system: the emigrés from the Soviet Union, who at that time were still to be found in great numbers in Western Europe. The Harvard research team in 1950 and 1951 conducted 764 long interviews and obtained completed questionnaires from nearly 3000 different emigrés. These were the basic new materials of the Harvard project and of this volume.

But consider the problem. There was no convincing way to project statistically from these emigrés back to the population of the Soviet Union; indeed, there was every reason to suspect that the emigrés differed in important ways from the people they left behind. Certainly the emigrés' feelings about the Soviet regime could hardly be assigned to the whole of the Soviet people. Furthermore, most of the emigrés had come out of the Soviet Union between 1943 and 1946, some of them still earlier. They knew very little about the U.S.S.R. as it was during the late years of Stalin, and they knew the striking changes that took place after Stalin's death only from hearsay and newspapers.

The members of the Harvard research team were admirably mature and restrained in their use of these data. They said quite properly that the material represented only "additional information" to be added to the standard sources. It could properly be used to illuminate some differences between subgroups in the population—for example, to compare some of the opinions and experiences of less educated with those of more highly educated persons—but not to project to the population as a whole. Some of the statistical materials in this book, as well as the fact that 8 years were spent in its preparation, testify to how much work was put in on the new materials, to try to determine, so far as possible, from internal evidence what could confidently be projected and how this matched other existing information.

Used in that way, and not depended on for too much, the emigré data were of important assistance. In 1951, before the Soviet Union was opened up to travel and exchange of materials, the data were more important than they are now.

This is the second general report of the Harvard project (in addition to two volumes of narrower scope and a number of small publications). The first general volume, *How the Soviet System Works* (Bauer, Inkeles, Kluckhohn, 1956), was concerned with the broad operating dynamics of the social system. The present book focuses on the individual, how he lives, and what he presumably likes and dislikes in Soviet society. It presents more of the tabular data from the interviews than any other of the project's publications, but the data are still put together in the only way we know to study a society to which we have very limited access—balancing source against source, fact against fact, new generalizations against old, and using what we have learned of accessible systems to help us interpret the inaccessible ones.

Inkeles and Bauer do a useful service in pointing out that the Soviet Union is both a totalitarian state and a vast industrial state, and that Soviet life and changes in it are related to interaction between these two over-arching systems. Thus, one can find evidence to support either Bertram Wolfe's analysis of the U.S.S.R. as a grim dictatorship, unchanged and unchanging, committed to destroying the free world, making treaties and agreements only as tactical maneuvers (this is the totalitarian face of the system), or, for Isaac Deutscher's somewhat more optimistic picture of an industrial society which contains the conditions for inevitable, gradual democratization, and which needs and seeks peace and stability (this is the public visage of the industrial system). But Inkeles and Bauer doubt that either position is the whole truth, or that either system is entirely in control. The question is not, they say, whether totalitarianism or industrialization will triumph, but rather how the two will resolve their relationship.

The crucial change in Soviet society, as Inkeles and Bauer see it, is that the main outlines of the system now seem to enjoy the support of popular consensus. Soviet policy was long aimed at securing reliable behavior regardless of how the person felt about what he was doing. The new policy, however, is to improve living standards, reduce terror, build pride in the strength of the regime—all with the intention of achieving broader support. Inkeles and Bauer feel that the tactic has been successful.

There is little apparent effect of ideological disaffection. There is some evidence of inter-class hostility, but the authors feel that such hostility is not dangerously high, could hardly find political channel for expression anyway, and can easily be manipulated by the regime by keeping the "haves" slightly insecure and the "have-nots" slightly hopeful. They find that discontent and alienation tend to focus selectively on leadership rather than on the full range of Soviet institutions. But,

on the other hand they do not feel that Soviet society shows signs of cleavage on a party and nonparty line. Rather, they see the party man gaining more respect as there comes to be less need to fear him. And they argue that one of the strengths of totalitarianism is that it co-opts into its ranks precisely those individuals who under other circumstances, would be "natural leaders."

Nor do the authors feel that nationalism or separatism is now at white heat among the nationality groups in the U.S.S.R. Instead, they see the peasant's values, centered on nationality, family, and religion, being replaced by those of the industrial society. To be sure, this too has its built-in tensions. For one thing, in order to give incentive, the regime has encouraged a cult of success, an upward mobility, a thirst for more education than the present system can provide. Ultimately the regime must come to grips with this by making manual labor more rewarding, both materially and psychologically. There has been bitter discontent with some of the conditions of Soviet industry—the enforced tempo of work, the terrible squeeze of work norms and piece rates, the harshness of labor regulations, and political interference with industry. But here the evidence is that conditions have changed notably for the better, and that workers are becoming better adjusted and satisfied.

In fact, throughout the data presented in this volume is the recurring theme of improving adjustment. Examining their data by age groups, Inkeles and Bauer find that the young people consistently react *more affirmatively* than their elders to what they consider to be the positive aspects of the system and *less violently* against the negative aspects. Each successive generation seems to take the system more for granted. Examining changing values in child care, the authors find that the traditional values of religion, respect for custom, and love of heritage are apparently being replaced by more secular values—adjustment, security, and so forth—which are more likely to produce a tractable citizen.

How might a fundamental change come about in the Soviet system? The authors suggest three ways. It might result from an internal conflict over the succession; from a break-up of the Soviet satellite empire; or from the gradual industrial maturing of the country. It is pointed out that either of the first two possibilities would be more likely to lead toward greater totalitarianism than toward greater democracy. The third type of change is one the authors feel must be considered very seriously. Indeed, they cite some of the changes already made in that direction since Stalin's death. But they point out that a change away from Stalinism is not necessarily a change *toward* democracy. The new Soviet society forged by Khrushchev, they say, "is perhaps less totalitarian, less absolutist, even less dictatorial. It is no less autocratic and certainly not *more* democratic, in the sense of acknowledging the supremacy of law and of individual rights. But such a society is more, not less, a challenge to the free world." This society represents a greater challenge because the leaders have succeeded in making adjustive changes without sacrificing the basic features or the intent of the system, and have gained greater efficiency, broader support from the citizenry, and a better profile before the world.

To a reader who feels that "everything will come out all right," this will be small encouragement. To a person (if one still exists) who believes that the Soviet Union is trembling on the brink of revolution, this book will not be a pleasant experience. But for anyone who wants a mature and perceptive examination, albeit from a distance, of the social psychology of the Soviet citizen, the Inkeles-Bauer book is recommended reading.

WILBUR SCHRAMM
*Center for Advanced Study in the Behavioral Sciences, Stanford, California*

**Communist Economic Strategy: The Rise of Mainland China.** A. Doak Barnett. National Planning Association, Washington, D.C., 1959. 106 pp. $2.50.

In 1956 the National Planning Association's International Committee organized a project to examine the economics of competitive coexistence, and this volume is the fourth in a series of country and area studies. The author, born and brought up in China, has served in the Far East as news correspondent, foreign service officer, and associate of the American Universities' field staff in Hong Kong.

While developing and documenting his central thesis that Communist China has already become an important participant in the economic competition between Communist and Western blocs, A. Doak Barnett takes full cognizance of the many difficulties inherent in the use of Chinese Communist statistics and in the assessment of Chinese Communist progress reports. In fact, although the book went to press several months prior to the recent down-grading by the Peking Government of their own previous claims, there is no evidence that these rectifications will in any sense damage Barnett's arguments. What emerges, rather, is a sober justification for his presentation of a China which, quite apart from its extravagant claims, is nevertheless making remarkable progress in a crash effort to industrialize itself.

Generally, Barnett's findings fall far short of being a reassurance for the West or for underdeveloped countries which, like India, are seeking to modernize through democratic rather than totalitarian means. Peking's policies have involved purges, suppressions of individual freedom, revolutionary upheaval, and economic hardship. And yet there is no doubt, according to Barnett, that "Peking's first Five Year Plan has put Communist China into the forefront of underdeveloped nations in terms of their rates of over-all growth. Especially startling, perhaps, has been the regime's decision to embark on foreign aid programs of its own to other underdeveloped countries."

If the annual increase in the gross national product during the first Five Year Plan was close to 7 or 8 percent, Barnett maintains, then the rate of growth in China has probably been close to double that of India. Contrary to a widely held assumption, moreover, the Chinese Communists have largely carried the burden of economic development themselves, for concrete assistance from the Soviet Union has been somewhat limited. The implications for further development during the second Five Year Plan, initiated in 1958, are difficult to assess, especially in view of the many over-inflated claims of last year, but the probable outcome, Barnett believes, should not be underestimated.

In conclusion, Barnett argues that Communist China's economic and industrial base will probably continue to grow at a comparatively rapid pace; that the Chinese Communists will con-

tinue to promote trade relations with the free world and particularly with the underdeveloped countries in Asia, the Middle East, and Africa; that Peking's foreign aid programs to countries in the Asian-African area will be expanded in the years immediately ahead; and that the psychological impact of Communist China's economic development will be widely felt throughout the underdeveloped areas of the world.

ROBERT C. NORTH
*Department of Political Science, Stanford University*

**Geochemical Methods of Prospecting and Exploration for Petroleum and Natural Gas.** A. A. Kartsev, Z. A. Tabasaranskii, M. I. Subbota, and G. A. Mogilevskii. English translation. Paul A. Witherspoon and William D. Romey, Eds. University of California Press, Berkeley, 1959. xxiii + 349 pp. Illus. $12.50.

The Russian edition of this book was published in 1954 as a text for students and also as a practical guide for petroleum geologists. In addition to the general reviews on the geochemistry of petroleum formations and natural gas, the following exploration techniques are outlined in considerable detail: gas surveys, core-gas surveys, oil and gas logging, bitumen and bitumen-luminescence methods, hydrochemical techniques, water-gas and soil-salt surveys, and microbiological methods. The oxidation-reduction technique and geobotanical prospecting methods are discussed in passing.

The editors of this English translation are to be congratulated for making this work available to those who do not read Russian. The translation is excellent, and the reader is assisted by occasional editorial footnotes.

Fundamentally, geochemical prospecting represents an attempt to obtain, directly or indirectly, criteria for recognizing oil and gas fields. In view of the necessity for basing such criteria upon the geochemistry of petroleum and gas, I was disappointed to find many misstatements, contradictions, and misconceptions in the very first chapter. This shortcoming is balanced, however, by the excellent descriptions of stationary and portable equipment for gas analysis, by a particularly good and objective discussion of bitumens that I recommend to geologists working with sedimentary deposits, and by an interesting description of microbiological exploration techniques.

The theoretical discussions of a number of techniques leave much to be desired. For example, decreases in redox potentials are attributed to the presence of hydrocarbons, but the fact that hydrocarbons are not ionized and cannot affect these potentials is overlooked.

I cannot help but wonder at the authors' obsession with regard to priority for the discovery, development, and use of many of the techniques described. The following statement illustrates this point: "The Americans unsuccessfully tried to appropriate the development and practical application of the [gas logging] method for themselves, ignoring the indisputable priority of Soviet investigators in this field." Such chauvinistic inserts add nothing to a scientific treatise and might not have been made if the authors had consulted more of the non-Russian literature.

Although there are shortcomings in the theoretical aspects of the book, the authors have carefully evaluated many of the parameters that can influence interpretation of experimental data; in one case 18 such factors are listed. Obviously, however, the ultimate value of these methods depends upon their usefulness in locating oil and gas, theoretical interpretations notwithstanding. In this respect, a number of examples are cited in which microbiological techniques have led to the discovery of oil at a depth of 1000 meters, or in which geochemical anomalies have been confirmed by later drilling. These are impressive results.

IRVING A. BREGER
*U.S. Geological Survey, Washington, D.C.*

**Index of American Palms.** Plates. B. E. Dahlgren. Field Museum of Natural History, Botanical Series, volume 14. Chicago Natural History Museum, Chicago, 1959. i + 412 pp. Illus. $10.

The 412 plates that comprise this volume supplement the *Index of Palms* text published in 1936. The volume includes photographs of types and other historic specimens of palms made under the direction of J. Francis Macbride prior to 1940 at several European herbaria—Copenhagen, Geneva, Herrenhausen (Hannover), Munich, Paris, and Vienna—and at the Museu Paraense Emilio Goeldi, in Brazil.

This is not a picture album showing photogenic palm trees but a collection of photographs of herbarium specimens, with the palm material pressed and dried, and reproductions of about 50 hitherto unpublished plates by F. M. Liebmann, a Danish student of palms who, a century ago, was professor of botany and director of the botanical garden at Copenhagen.

In general, the quality of the photographs and the offset printing is excellent, and the pictures can be considerably magnified to show the details of plant parts. Unfortunately, in several cases, focusing on the slightly raised plant parts resulted in a loss of sharpness, and the label data were lost. Within the usual limitations imposed when illustrations are substituted for the actual specimens, these photographs will be useful to taxonomists for reference purposes.

The earlier work in the same series, *Index of American Palms* (Publication 355, 1936) is out of print. It included a complete index of American palm genera and species, and lists of data—such as taxonomic literature, vernacular names, and geographic occurrence (prepared by B. E. Dahlgren), and a list of fossil palms (by A. C. Noé).

Dahlgren is now the dean of American palm specialists, and although for more than a decade he has been curator emeritus at the Chicago Museum of Natural History (formerly the Field Museum), he continues his studies in the palm family.

VELVA E. RUDD
*U.S. National Museum, Smithsonian Institution*

**The Amphetamines.** Their actions and uses. Chauncey W. Leake. Thomas, Springfield, Ill., 1958. xv + 167 pp. $4.50.

This book might be called a gem monograph. It is an easily read account of the amphetamines, written for the general reader as well as for the physician. Therapeutic details do not obtrude on the historical and philosophical story, which Leake has written in his fluent style.

After a charming dedication to Gordon Alles, the book describes the three

amphetamines, dextro, levo, and methyl derivative, and their relationships to the natural sympathetic mediators and synthetic relatives. Although there are major chemical and phamacological qualities common to the entire group, accentuations of the cardiovascular, respiratory, and central nervous effects allow subdivision into these respective types. The amphetamines fit particularly well into the latter division, for they induce wakefulness, lessen fatigue, and lighten mood. In fact, they might be called the charter members of the new psychic energizer society. The mechanism of their action may be in part a blocking of amine oxidase, an enzyme which normally is free to destroy natural sympathomimetic agents, and in part direct stimulation of the normal receptors for the latter agents.

Much attention has been paid to the toxic potentialities of the amphetamines. Ordinarily the hazard is slight, but abuse may lead to excessive fatigue and possibly to mental disturbances. In animals, addiction is possible, though its existence in man is largely one of definition. This is discussed in the last chapter, "Sociological aspects," where both the author's observations in Japan and his broad general interests contribute to a most interesting assessment.

It is a pleasure to note the appearance of this volume on the eve of Chauncey Leake's elevation to the presidency of the American Association for the Advancement of Science. The book is characteristic of an able man of many interests.

WINDSOR CUTTING
*Department of Medical Microbiology, Stanford University School of Medicine*

**Applied Solar Energy Research**. A directory of world activities and bibliography of significant literature. Jean Smith Jensen, Ed. Association for Applied Solar Energy, Phoenix, Ariz., ed. 2, 1959. xxi + 275 pp.

*Applied Solar Energy* is intended to provide a central catalog of the world literature on applied solar energy and of the activities of laboratories and individuals at present engaged in this area of research.

The scope of the bibliography has been somewhat restricted in this edition. Several related areas—"Control of the sun in architecture, day-lighting, and . . . the architectural aspects of weather; the influence of the sun on weather; solar physics; and other sources of (unconventional) energy"—have been omitted, and only a few papers on photosynthesis are listed.

In gathering information for the section covering world research activities, questionnaires were mailed to research groups currently or recently engaged in solar research. The activities are grouped alphabetically by country and, for each country, alphabetically by name of the laboratory. The summary for each laboratory includes a brief description of projects completed since 1955 or now under way. In most cases, the scientists active in the program are listed.

The bibliography section is arranged by subject, and there is an author index. Under each subject, the arrangement is chronological; cross references are used. The literature searched included *Chemical Abstracts, Physics Abstracts, Applied Science and Technology Index, Electrical Engineering Abstracts, Fuel Abstracts,* and earlier bibliographies in the field. An attempt was made to fill in material published up to the end of 1954 (the cut-off date for the first edition) and to cite papers published since that date.

In the introduction, Farrington Daniels reviews the progress made since 1955 and comments on important advances. Daniels remarks, "Considering all the fields of activity in solar energy utilization that have been reviewed here, it is evident that considerable progress has been made in research and development during the four years since the Arizona Symposia in 1955."

## New Books

*Biological Psychiatry*. Jules H. Masserman, Ed. Grune and Stratton, New York, 1959. 354 pp. $9.75. The proceedings of the scientific sessions of the Society of Biological Psychiatry held at San Francisco in May 1958. pt. 1, "Neuroanatomy and neurophysiology"; pt. 2, "Clinical research"; pt. 3, "Psychopharmacologic research"; pt. 4, "Drugs in psychiatric therapy"; pt. 5, "Evaluations and discussions."

*Chemical Process Principles.* pt. 2, *Thermodynamics.* Olaf A. Hougen, Kenneth M. Watson, Roland A. Ragatz. Wiley, New York; Chapman and Hall, London, ed. 2, 1959. 680 pp. $9.75.

*College Arithmetic.* W. I. Layton. Wiley, New York; Chapman and Hall, London, 1959. 212 pp. $3.50.

*The Concepts of Sigmund Freud.* Bartlett H. Stoodley. Free Press, Glencoe, Ill., 1959. 286 pp. $6.

*Diagnostic Laboratory Hematology.* George E. Cartwright. Grune and Stratton, New York, ed. 2, 1958. 261 pp. $6.75.

*Dictionary of Aeronautical Engineering.* J. L. Nayler. Philosophical Library, New York, 1959. 324 pp. $10.

*An Electronic Outline of Organic Chemistry.* S. Horwood Tucker. Univ. of London Press, London, 1959. 494 pp. 63s.

*The Encyclopedia of Witchcraft and Demonology.* Rossell Hope Robbins. Crown, New York, 1959. 571 pp. $7.50.

*Engineering Mechanics Statics.* Irving H. Shames. Prentice-Hall, Englewood Cliffs, N.J., 1959. 303 pp. $4.75.

*Exotic Aquarium Fishes.* A work of general reference. William T. Innes. George S. Myers, Ed. Innes, Philadelphia, Pa., ed. 19, 1959. 541 pp. $9.75. Fishes that have proved their worth as aquarium pets are described and illustrated; fishes that cannot be kept in aquariums or that cannot be obtained are excluded. Information on the care of fish is included and chapters are devoted to plants, classification of fishes, and collecting and transporting of fishes.

*Extractive Metallurgy.* Joseph Newton. Wiley, New York; Chapman and Hall, London, 1959. 539 pp. $9.75.

*Foundry Engineering.* Howard F. Taylor, Merton C. Fleming, John Wulff. Wiley, New York; Chapman and Hall, London, 1959. 414 pp. $9.75.

*The Heinz Handbook of Nutrition.* A comprehensive treatise on nutrition in health and disease. Published for H. J. Heinz Co. McGraw-Hill, New York, 1959. 449 pp. $5.75.

*Metabolism in the Rumen.* E. F. Annison and D. Lewis. Methuen, London; Wiley, New York, 1959. 184 pp. $2.75.

*The Moon Car.* Hermann Oberth. Translated by Willy Ley. Harper, New York, 1959. 98 pp. $2.95.

*Narcotics.* Lingo and lore. J. E. Schmidt. Thomas, Springfield, Ill., 1959. 213 pp. $4.25.

*The Natural Thing.* The land and its citizens. Pieter W. Fosburgh. Macmillan, New York, 1959. 263 pp. $4.75. A collection of essays on conservation. Fosburgh was editor of the *New York State Conservationist* for 10 years; some of the essays are expanded and rewritten material from that publication.

*Neuropharmacology.* Transactions of the fourth conference, 25–27 September 1957, Princeton, N.J. Harold A. Abramson, Ed. Josiah Macy, Jr. Foundation, New York, 1959. 285 pp. $5.

*New Dimensions of Flight.* Lewis Zarem. Dutton, New York, 1959. 256 pp. $4.50.

*Nomography.* A. S. Levens. Wiley, New York; Chapman and Hall, London, ed. 2, 1959. 304 pp. $8.50.

*Normal Children and Mothers.* Their emotional opportunities and obstacles. Irving D. Harris. Free Press, Glencoe, Ill., 1959. 297 pp. $6.

*University Mathematics.* A textbook for students of science and engineering. Joseph Blakey. Philosophical Library, New York, ed. 2, 1959. 581 pp. $10.

*The Vegetation of Wisconsin.* An ordination of plant communities. John T. Curtis. Univ. of Wisconsin Press, Madison, 1959. 668 pp. $7.50.

# Reports

## Blood Flow Rates by Nuclear Magnetic Resonance Measurements

*Abstract.* Blood flow rates may be determined by nuclear magnetic resonance relaxation time measurements. A set of experiments carried out on the flow of blood in mice tails has demonstrated the feasibility of the scheme. Two simple measurement methods are described, and the pertinent equations are given. In addition, some procedures for using nuclear magnetic resonance and electron paramagnetic resonance for tracing the flow of specific materials in the body are outlined.

This paper reports on the application of nuclear magnetic resonance (NMR) techniques to the study of blood flow rates in mice. These animals were chosen to illustrate the method, but there is no limitation implied. We expect soon to measure blood flow rates in the fingers or arms, or both, of human beings. Since the power input involved is less than 0.01 watt of 60 Mcy/sec radio-frequency (R-F) waves, there is no danger to the subject. In this regard, the method is superior to the use of radioactive tracer substances with counters and is clearly preferable to puncturing the veins or arteries as in certain conventional procedures. Nonetheless, it may be well to compare initial measurements with measurements made by other systems, since then the precision may be established.

Several methods have been employed, and all are satisfactory, but some are easier to use and are more precise than others. One procedure is to measure the nuclear relaxation time of the protons in the water of the blood and then note the apparent change in relaxation time after tightening a tourniquet to stop the flow of blood. The means of such relaxation time measurements are known from physical investigations of the nuclei of gases, liquids, and solids (*1–3*).

The simplest method of measurement consists of the following procedure. The NMR R-F absorption curve is determined with no flow—that is, with a tourniquet applied. Next, the tourniquet is removed and another absorption curve observed. Since the flow results in less saturated nuclei entering the observation region, the absorption curve with blood flow is larger in amplitude. The absorption is in fact proportional to the saturation factor,

$$[1 + \tfrac{1}{2}\gamma^2 H_1^2 T_1 g(\nu)]^{-1}$$

where $\gamma$ is the nuclear gyromagnetic ratio, $H_1$ is the R-F magnetic field intensity, $T_1$ is the thermal relaxation time, and $g(\nu)$ is the normalized shape function for the resonance line.

Derivations of the formulas will appear in a later, more expanded paper. Only the more important results are quoted below.

The theoretically expected apparent relaxation time $(T_1)'$ of a liquid flowing at a rate less than $V_0/T_1$ (where $V_0$ is the sample volume under observation, and $T_1$ is the static, that is, nonflowing thermal relaxation time of the liquid) is given by:

$$(T_1)' = T_1 V_0/(V_0 + hT_1) \qquad (1)$$

where $h$ is the volume fluid flow per second. Using this relationship and the fact that the signal strength is reduced by a saturation factor, the increment of signal amplitude $(A_f - A)$ due to flow, divided by the amplitude of the signal without flow $A$, is given by:

$$\frac{A_f - A}{A} = \frac{s\left(1 - \dfrac{V_0}{V_0 + hT_1}\right)}{1 + s\left(\dfrac{V_0}{V_0 + hT_1}\right)} \qquad (2)$$

where

$$s = \tfrac{1}{2}\gamma^2 H_1^2 T_1 g(\nu)$$

When notable saturation of the signal occurs, as in our experiments with blood flow, $s$ is much larger than unity, and Eq. 2 may be approximated by

$$\frac{A_f - A}{A} \approx \frac{hT_1}{V_0} \qquad (3)$$

Consequently, this simple formula gives the rate of blood flow after three measurements. Our experiments were as follows. The first measurement consists of determining $T_1$ for the blood by one of the standard methods (*1–3*) while a tourniquet is applied. We mostly used the saturation method. The determination of $T_1$ should take a minute or so, and thus presents no difficulty from blood stoppage. Next, the height of the absorption curve is observed by means of an oscilloscope and noted as height $A$. Finally, the tourniquet is removed, and the absorption curve is again observed on the oscilloscope and noted as height $A_f$. Equation 3 now gives the average linear flow rate $v$, in centimeters per second, as

$$v = \frac{(A_f - A)L_0}{AT_1} \qquad (4)$$

where $L_0$ is the length of tail in the R-F field of measurement.

The major source of error in applying Eq. 4 to blood flow in vivo is that the protons of the water in the tissues also contribute to the amplitudes $A$ and $A_f$. For this reason, we advocate Eq. 4 only when relative velocities are desired. In that case one takes the ratio of two values of velocity, and the static proton contributions vanish. In this manner we have measured the relative velocity of blood flow in standard white laboratory mice when sedated with ether and sodium pentothal. The tail flow velocity was 4.5 times faster for ether-sedated mice over the pentothal-sedated mice.

Another design, now under construction, will be employed to measure absolute values of blood flow velocities. The method consists of having two sets of coils separated by a distance $x$. One set of coils is connected with an R-F transmitter and receiver to monitor the R-F resonant absorption. The second coil is associated with an R-F transmitter which is pulsed at a predetermined time. The pulse of R-F can be allowed to cause saturation or inverse polarization of the local nuclei (*1, 3*). At the instant of pulsing, a time base is generated for an oscilloscope sweep. By estimating the time for the perturbed nuclei to reach the monitoring point, the flow velocity is determined. More explicitly, $x$ divided by the time between the pulse and the monitor signal disturbance gives the average velocity. (The term "average

---

*Instructions for preparing reports.* Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

velocity" refers to the fact that the flow is laminar, hence there is a velocity distribution of which the average is measured.)

The latter measurement system is applicable to instantaneous velocity measurements; that is, one would be able to measure flow between heart beats as well as during a heart beat, provided that the distance $x$ is chosen small relative to the total distance of fluid travel between heart pumps.

There is no problem of obtaining magnetic field homogeneity over the region of a human finger, but there is some difficulty if measurements are contemplated in a large region such as the human neck. We are planning to measure absolute blood velocities in human fingers as our next project.

It is difficult to attempt a comparison of different flow velocity systems at this stage of development, but in our opinion the nuclear resonance measurement system has potentialities unequaled by any other method. In essence, an NMR measurement implants disturbed nuclei whose path may be traced for any length of time up to the relaxation time $T_1$. For mouse blood, $T_1$ is approximately 0.4 sec. Human blood has a relaxation time of the same order of magnitude.

One additional important set of experimental possibilities should be mentioned. One may use nuclear or *electron* magnetic resonance as a tracer detection system. For example, consider the digestion or injection of substances containing nickel, cobalt, iron, or other transition metal salts. These may be detected in the bloodstream in vivo by means of electron paramagnetic resonance.

Detection of as little as one billionth of a gram of paramagnetic material has been achieved; however, it is expected that R-F losses due to surrounding body tissues will reduce the sensitivity somewhat. Nuclear resonance techniques may also be utilized in conjunction with specific tracer substances—almost every chemical has its own specific resonance spectrum and a host of materials would serve as tracers (*4*).

J. R. SINGER

*Department of Engineering,*
*University of California,*
*Berkeley*

### References and Notes

1. F. Bloch, *Phys. Rev.* **70**, 460 (1946); ——, W. W. Hansen, M. Packard, *ibid.* **70**, 474 (1946).
2. N. Bloembergen, E. M. Purcell, R. V. Pound, *ibid.* **73**, 697 (1948).
3. E. Hahn, *ibid.* **80**, 580 (1950).
4. It is a pleasure to acknowledge numerous stimulating conversations with Professors Enoch Callaway III and Robert E. Harris which initiated my interest in biological measurements.

12 June 1959

## Stimulation of Amino Acid Transport in Isolated Diaphragm by Growth Hormone Added in vitro

*Abstract.* The influence of the pituitary on the transport of α-aminoisobutyric acid-1-$C^{14}$ into the cells of isolated rat diaphragm was investigated. Hypophysectomy results in a lower-than-normal rate of α-aminoisobutyric acid-1-$C^{14}$ penetration into muscle. Adding either simian or bovine growth hormone preparations to the incubation medium in concentrations of 2.5 to 25 μg/ml of medium resulted in a doubling of the α-aminoisobutyric acid-1-$C^{14}$ penetration rate. The stimulatory effect was minimized when the hormone concentration was reduced to 0.25 μg/ml of medium.

The incorporation of leucine-2-$C^{14}$ into the protein of isolated rat diaphragm is markedly reduced by hypophysectomy and stimulated by chronic treatment with bovine growth hormone (*1*, *2*) or by the addition of simian growth hormone to the incubation medium in low concentrations (*3*). Although there are many possible explanations for these pituitary effects on amino acid incorporation, it is conceivable that the effects could result, in part, from alterations in the rate of entry of amino acids into the intracellular amino acid pool. The experiment of Noall *et al.* (*4*), in which an acute injection of growth hormone enhanced the cellular concentration of the nonutilizable amino acid, α-aminoisobutyric acid (AIB), suggested that growth hormone might exert an influence on amino acid transport. The present investigation was undertaken to determine the effects of hypophysectomy and growth hormone, added in vitro, on the rate of penetration of AIB-1-$C^{14}$ into the cells of the isolated diaphragm.

Fed female rats of the Charles River strain weighing 60 to 80 gm were used in all experiments. The rats employed in the first series of experiments (Fig. 1) were hypophysectomized 40 days before sacrifice, while those used in the second series (Fig. 2) were hypophysectomized 14 days before the experiment. The method used to measure AIB-1-$C^{14}$ transport was a modification of the procedure described by Kipnis and Noall (*5*). The animals were killed by a blow on the neck, and the diaphragms were rapidly prepared according to the method of Kipnis and Cori (*6*). The "intact" diaphragm preparation was blotted on filter paper and transferred to 125-ml flasks containing 30 ml of Krebs bicarbonate buffer, *p*H 7.4. Glucose was added to the buffer at a concentration of 0.01 mole/lit. and AIB-1-$C^{14}$ at a concentration of 0.05 mmole/lit. (25,000 count/min × ml of medium). The AIB-1-$C^{14}$ was obtained from Isotope Specialties Co., Inc., at a specific activity of 1 mc/mmole. Growth hormone preparations of simian (M425B) and bovine (NIH-BGH-1) origins were dissolved in 0.15 ml of distilled water at *p*H 8 and added to the medium immediately prior to the beginning of an experiment. An equivalent amount of distilled water at *p*H 8 was added to the control flasks. The medium in the flasks was preheated to 37°C, so that the timing of the incubation period commenced with the addition of the diaphragm preparation to the flask. Immediately after the addition of the tissue, the flask was gassed with 95 percent $O_2$–5 percent $CO_2$ for 5 minutes and then sealed. Incubation was carried out with shaking (100 cy/min) for various periods up to 2 hours. At the end of the incubation period, the diaphragm muscle was dissected away from ribs and adhering tissue, washed for 10 seconds in two changes of buffer, weighed, and homogenized in 1.0 ml of 0.008*N* acetic acid. The homogenate was centrifuged, and the supernatant was diluted 1:1 with 1 percent sucrose. Aliquots of the diluted supernatant were plated at infinite thinness on aluminum planchets and after drying were counted with a gas-flow, thin end-window counter.

The results are presented as the ratio

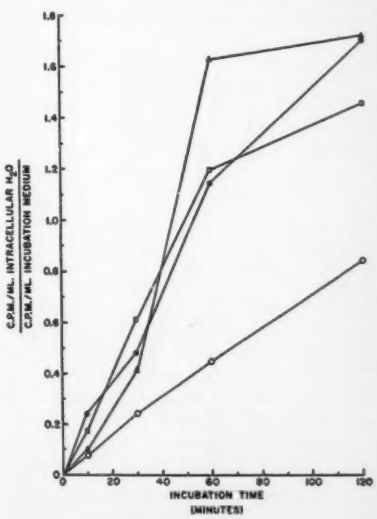



Fig. 1. Penetration of AIB-1-$C^{14}$ into "intact" rat diaphragm preparations. ●, normal; ○, hypophysectomized; △, hypophysectomized + simian growth hormone added to medium (25 μg/ml); □, hypophysectomized + bovine growth hormone added to medium (25 μg/ml). Each point represents one observation, except for the hypophysectomized controls, which represent the mean of three observations per point.

of counts per minute per milliliter of intracellular water to counts per minute per milliliter of incubation medium. The activity of intracellular water was determined by subtracting the radioactivity in the extracellular volume from that in the total tissue water. Total tissue water and extracellular volume were determined under incubation conditions similar to those used in the AIB-1-$C^{14}$ experiments. Total tissue water was obtained by drying diaphragms to constant weight at 105°C, and extracellular volume was obtained by isotope dilution, employing sucrose uniformly labeled with $C^{14}$. Sucrose-$C^{14}$ distribution reached an apparent equilibrium after approximately 15 minutes of incubation, but increased about 2 percent between 1 and 2 hours of incubation. After 2 hours of incubation, the sucrose-$C^{14}$ space of normal tissue was found to be slightly higher (19.3 percent) than that of muscle of hypophysectomized rats (17.4 percent). The addition of growth hormone preparations to the medium did not markedly alter the magnitude of the sucrose-$C^{14}$ space. In some experiments, amino acid nitrogen determinations (*7*) were made on aliquots of the medium following incubation to ascertain the amount of amino acid nitrogen released by the tissue.

The results are given in Figs. 1 and 2, in which the penetration of AIB-1-$C^{14}$ into muscle is plotted against incubation time. AIB-1-$C^{14}$ enters muscle cells of hypophysectomized rats at a lower-than-normal rate (Fig. 1). Adding either simian or bovine growth hormone preparations to the medium at a concentration of 25 $\mu$g/ml greatly enhanced the uptake of AIB-1-$C^{14}$ by the diaphragms of hypophysectomized rats. The fact that both simian and bovine growth hormones stimulated entry of AIB-1-$C^{14}$ into islolated diaphragm was of particular interest, since only simian growth hormone was found to consistently stimulate leucine-2-$C^{14}$ incorporation into diaphragm protein when added in vitro (*2*). When the concentration of the hormone preparations was reduced to 2.5 $\mu$g/ml of medium there was still a doubling in the rate of AIB-1-$C^{14}$ penetration (Fig. 2). However, a further 10-fold reduction in hormone concentration nearly eliminated the stimulatory effect. The greater rate of AIB-1-$C^{14}$ penetration in the hypophysectomized controls in the second series of experiments (Fig. 2) may be related to the shorter time (14 days) that they were hypophysectomized.

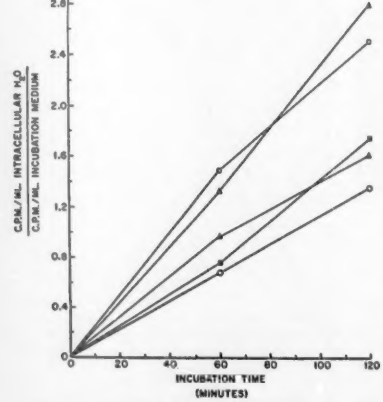



Fig. 2. Effect of low in vitro concentrations of growth harmone preparations on the penetration of AIB-1-$C^{14}$ into "intact" diaphragms of hypophysectomized rats. ○, hypophysectomized control; △, simian growth hormone (2.5 $\mu$g/ml); ▲, simian growth hormone (0.25 $\mu$g/ml); □, bovine growth hormone (2.5 $\mu$g/ml); ▩, bovine growth hormone (0.25 $\mu$g/ml). Each point represents one observation.

Measurements of the amounts of amino acid nitrogen released into the medium during these experiments indicated that on a tissue-weight basis, the "intact" diaphragm preparation of a normal rat released somewhat more amino acid nitrogen into the medium than did that of a hypophysectomized animal, confirming the observations of Kline (*8*). The addition of growth hormone preparations to the medium had no effect on the rate of release of amino acid nitrogen. Since the amounts of tissue used in most experiments were approximately equivalent, the concentration of amino acid nitrogen in the medium at any time during the incubation was roughly comparable between experimentals and controls, differing only rarely by as much as 5 $\mu$g/ml of medium. Thus, the hormonally induced differences in AIB-1-$C^{14}$ transport noted in these experiments are probably not ascribable to changes in the concentration of nonlabeled, endogenously produced amino acids.

The experiments presented here support the hypothesis that pituitary growth hormone plays a role in the regulation of amino acid transport into muscle cells. Should growth hormone be found to stimulate the transport of natural amino acids as well, then the increase in amino acid incorporation into protein produced by this hormone might well be due, in part at least, to an initial increase in the availability of amino acid (*9*).

J. L. KOSTYO*
J. HOTCHKISS†
E. KNOBIL
*Department of Physiology, Harvard Medical School, Boston, Massachusetts*

**References and Notes**

1. J. L. Kostyo and E. Knobil, *Federation Proc.* **18**, 84 (1959).
2. ———, *Endocrinology* **65**, 395 (1959).
3. ———, *ibid.* **65**, 525 (1959).
4. M. W. Noall, T. R. Riggs, L. M. Walker, H. N. Christensen, *Science* **126**, 1002 (1957).
5. D. M. Kipnis and M. W. Noall, *Biochim. et Biophys. Acta* **28**, 226 (1958).
6. D. M. Kipnis and C. F. Cori, *J. Biol. Chem.* **224**, 681 (1957).
7. E. G. Frame, J. A. Russell, A. E. Wilhelmi, *ibid.* **149**, 255 (1943); J. A. Russell, *ibid.* **156**, 467 (1944).
8. D. L. Kline, *Endocrinology* **45**, 596 (1949).
9. We wish to express our gratitude to A. E. Wilhelmi for generously supplying the simian growth hormone used in these experiments. The bovine growth hormone was a gift of the endocrinology study section of the National Institutes of Health. This study was supported by a grant from the American Cancer Society (P-139A).
* National Research fellow in the medical sciences. Present address: Department of Medicine, Duke University Medical Center, Durham, N.C.
† Predoctoral research fellow, National Institutes of Health.

27 July 1959

## Stimulation of Striga asiatica (Witchweed) Seed Germination by 6-Substituted Purines

*Abstract.* Kinetin [6-(2-furfuryl)aminopurine] and certain other 6-substituted aminopurines stimulated germination of seed of *Striga asiatica* (L.) Kuntze. Optimum concentration for most active compounds was in the range of 5 to 25 mg/lit. Derivatives which showed high activity possessed an adenine nucleus with a phenyl, benzyl, phenethyl, or furfuryl radical substituted on the amino group.

*Striga asiatica* (L.) Kuntze, an angiospermous root parasite indigenous to several tropical and subtropical areas of the Eastern Hemisphere, was discovered in the coastal plain section of North Carolina and South Carolina in 1956. This species threatens warm-season gramineous crops in the infested regions. Consequently, attention is being focused for the first time in the United States on problems associated with the growth, development, and control of this particular plant parasite.

Germination of *Striga* seed depends upon a substance (or substances) secreted by the roots of host and certain other plant species (*1*). The natural germination stimulant of *Striga* spp. has not been identified. However, a sugar, D-xylulose, was reported to be very effective in promoting germination of seed of *S. hermonthica* (Del.) Benth. but did not appear to be a constituent of the root exudate of *Sorghum vulgare* (*2*). In conjunction with efforts to isolate and characterize the chemical stimulant, or stimulants, in root exudates of seedlings of corn, *Zea mays* L., various organic and inorganic compounds were tested for their ability to induce seed germination. In preliminary tests 6-(2-furfuryl)aminopurine

(kinetin) (*3*) was found to stimulate germination. Subsequently, the germination-stimulation potentials of other 6-substituted purines (*4*) were examined.

*Striga* seed used in this study were collected during the summer of 1957 and stored at room temperature. The seed are very small and even after imbibing water measure only approximately 0.15 by 0.20 mm. Prior to being used in germination tests, the seed were preconditioned for 15 to 20 days on moist filter paper in the dark at 23° to 24°C. The requirements for preconditioning in order to obtain maximum germination in laboratory studies have been previously established (*2*) and were reconfirmed in the study reported here. In the germination tests a small piece (about 4 by 7 mm) of moist filter paper holding 50 to 100 seed was blotted of excess moisture and floated on 0.2 ml of the solution being tested. This solution was contained in the depression or well of a spot test plate. The entire plate was covered by a thin sheet of polyethylene and sealed around each well with mineral oil. The plate containing the seed was then placed in the dark in a germinator at 33° ± 1°C. After 24 hours, germination counts were made under 30× magnification and the results were expressed as percentages of germination. Seed were considered to have germinated when the hypocotyl had emerged from the seed coat and had attained a length one-half that of the seed.

A standard germination stimulant and distilled water were incorporated in all tests as controls. A solution obtained by growing the roots of about 35 corn seedlings in 400 ml of aerated distilled water for 5 to 10 days in the dark served as the standard stimulant. When applied to preconditioned seed this solution consistently produced 75 to 85 percent germination within 24 hours. Germination did not increase appreciably beyond this period. The seed seem to have no requirement for red light, and germination was slightly inhibited if the seed were exposed to incandescent light during germination. Germination of seed in distilled-water controls did not occur in these studies. The purine analogs were tested at concentrations of 50, 25, 10, 5, 1, 0.5, and 0.1 mg/lit.

A stock solution containing 50 mg/lit. of distilled water was initially prepared for each compound. Adjustment of the *p*H to approximately 11.2 with NaOH was required to dissolve most of the compounds. Then the *p*H was readjusted to approximately 6.5 with HCl. The results obtained with control solutions which received comparable adjustments in *p*H did not differ from those obtained with unadjusted controls.

Table 1. Effect of various 6-substituted purines on the germination of *Striga asiatica* seed.

| Compound | Mean germination* (%) at indicated concentration | | | Mean germination for 3 rates (%) |
|---|---|---|---|---|
| | 25 mg/lit. | 10 mg/lit. | 5 mg/lit. | |
| 6-Phenylaminopurine | 39 | 81 | 73 | 64 |
| 6-(2-Thenyl)aminopurine | 54 | 52 | 63 | 56 |
| 6-(2-Phenethyl)aminopurine | 48 | 75 | 38 | 54 |
| 6-Benzylaminopurine | 12 | 70 | 52 | 45 |
| 6-(2-Furfuryl)aminopurine (kinetin) | 24 | 62 | 27 | 38 |
| Benzaldehyde-6-purinylhydrazone | 62 | 17 | 7 | 29 |
| 6-(*o*-Chlorobenzyl)aminopurine | 1 | 21 | 32 | 18 |
| 6-Hexylaminopurine | 1 | 6 | 42 | 16 |
| 6-(*p*-Chlorobenzyl)aminopurine | 1 | 32 | 9 | 14 |
| 6-(Tetrahydrofurfuryl)aminopurine | 20 | 3 | 1 | 8 |
| 6-(Furfuryl)-6-(methyl)aminopurine | 8 | 3 | 0 | 4 |
| 6-Benzylthiopurine | 0 | 6 | 1 | 2 |
| None (water blank control) | | | | 0 |
| None (standard stimulant control) | | | | 81 |

* Average of two replications.

Maximum germination for each compound was obtained at the concentrations shown (Table 1) except for 6-hexylaminopurine and benzaldehyde-6-purinylhydrazone, which produced 45 and 89 percent germination at concentrations of 1 mg and 50 mg/lit., respectively. Most of the active compounds appeared to become inhibitory at concentrations above 10 mg/lit. For comparative purposes, the compounds are listed in Table 1 in an order based on an average germination value obtained by averaging the germination measured at concentrations of 5, 10, and 25 mg/lit. This is an arbitrary ranking and does not necessarily give an accurate indication of the germination-stimulating capacity of the compounds. The following compounds, not listed in Table 1, were inactive in this study: purine (free base); adenine; 6-(1-piperazinyl)purine; 5-nitro-2-furaldehyde-6-purinylhydrazone; 6-(hydroxyethyl)aminopurine; 6-bis(hydroxyethyl)aminopurine; (6-purinylthio)acetic acid; 6-(3-dimethylaminopropyl)aminopurine; and 6-(2,2-dimethylhydrazino) purine.

The highly active compounds were 6-substituted aminopurines in which the substituent group consisted of a phenyl, benzyl, phenethyl, or furfuryl radical. Activity was decreased when the benzene ring was chlorinated, the furfuryl ring was saturated, or the remaining amino hydrogen was replaced by a methyl group. Replacement of the oxygen in the furfuryl moiety by sulfur produced a compound which was even more active than kinetin. Among the compounds tested which contained aliphatic groups, only 6-hexylaminopurine was active. It was much less active than the compounds having a ring for the substituent group. The 6-benzylthiopurine was only slightly active in stimulating germination in *Striga* seed. However, it is very active in promoting germination in lettuce seed (*5*). Consequently, structural specificity of the 6-substituted purines seems to be somewhat more exacting for germination in *Striga* seed than for germination in lettuce seed. From a consideration of the kinetin analogs evaluated in this study, it appears that the structural requirements for stimulation of germination in *Striga* seed correspond closely to those for high cell-division-stimulating activity in the tobacco callus growth test (*6*).

Results of these studies suggest that in the stimulation of germination in *Striga* seed the 6-substituted aminopurines may participate in reactions governing germination not activated by light (*5*, *7*).

Differences were noted between hypocotyls of seed stimulated to germinate by the 6-substituted purines and those in which germination was promoted by the natural stimulant present in the corn-root exudate. When the latter was used, the hypocotyls were long and slender. Elongation of the hypocotyls continued for 4 to 5 days, and the hypocotyls reached a length of 2 to 3 mm. After about 6 days the hypocotyls became flaccid, and the cells became discolored and eventually died. When purine derivatives were used at threshold concentrations, the hypocotyls had the same appearance as those treated with the natural stimulant. At all higher concentrations, however, the hypocotyls consisted of a bulbous mass of small cells. Root-hair-like protuberances were usually observed growing from epidermal cells. Within 4 to 5 days the hypocotyls began to elongate from each of the bulbous structures, and the cotyledons enlarged and emerged from the seed coats. Elongation of the shoot apex beyond the two first leaf or scale primordia was observed in some of the treatments. So far as we know this is the first time development of this type has been reported for *Striga* seedlings that

have not made haustorial connections with the host roots. The slowly developing seedlings remained alive for several weeks in the initial purine solutions. Seedlings stimulated by, and left in contact with, the natural stimulant solution did not develop enlarged cotyledons or undergo elongation of the shoot apex (*8*).

A. D. WORSHAM
*Department of Field Crops, North Carolina State College, Raleigh*
D. E. MORELAND
*Agricultural Research Service, U.S. Department of Agriculture*
G. C. KLINGMAN
*Department of Field Crops, North Carolina State College*

**References and Notes**

1. R. Brown and M. Edwards, *Ann. Botany* **8**, 131 (1944); C. Fuller, *Agr. J. Union S. Africa* **1**, 684 (1911); H. H. W. Pearson, *ibid.* **3**, 651 (1912); A. R. Saunders, *Union S. Africa Dept. Agr. Sci. Bull.* **128**, (1933); K. B. Vallance, *Ann. Botany* **14**, 347 (1950).
2. R. Brown *et al.*, *Proc. Roy. Soc.* (*London*) **B136**, 1 (1949); ———, *Biochem. J.* **50**, 596 (1952); A. R. Lansdown, *Univ. of Cambridge Abstr. Diss.* (1953–54), p. 234; A. G. Long, *ibid.* (1952–53), p. 202; G. J. Tyler, *ibid.*, p. 213.
3. The kinetin used in this study was purchased from Nutritional Biochemicals Corp., Cleveland, O.
4. The other 6-substituted purines were generously supplied by Charles G. Skinner of the University of Texas, Austin, and by Parke, Davis and Co., Detroit, Mich.
5. C. G. Skinner and W. Shive, *Arch. Biochem. Biophys.* **65**, 567 (1956); *Plant Physiol.* **32**, 117 (1957).
6. F. M. Strong, *Topics in Microbial Chemistry* (Wiley, New York, 1958).
7. C. O. Miller, *Plant Physiol.* **31**, 318 (1956); *ibid.* **33**, 115 (1958).
8. These studies were cooperative investigations of the North Carolina Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture. This report is published with the approval of the North Carolina Agricultural Experiment Station as paper No. 1066.

30 July 1959

## New Permian Insects Discovered in Kansas and Oklahoma

*Abstract.* The Midco insect bed of Oklahoma and a newly discovered insect bed above this were traced across Kay County, Okla., into Sumner County, Kan. As a result, a greater time span is available for study of insect evolution during the mid-continent Permian, and the exact stratigraphic correlation of the Wellington of Oklahoma and Kansas can now be demonstrated. Four insect orders have thus far been identified from the new insect bed: Protodonata, Odonata, Protoperlaria, and Ephemeroptera. Numerous new species and higher categories are included in the collections from the two insect beds.

In 1939 the famous Midco insect bed (Permian, Leonardian, Wellington formation) of Noble County, Okla., was discovered by G. O. Raasch (*1*) and subsequently explored by Raasch and F. M. Carpenter (*2*). Slightly northwest of a locality in southern Kay County where Raasch had previously reported no insects, Tasch, aided by his assistant, Bernard Shaffer, found insects in the Midco bed. In addition, some 8 ft above the Midco, a new insect bed was discovered (NW-SW, sec. 31, T 25 N, R 1 W).

The Midco insect bed and the new insect occurrence above it were both traced to northern Kay County (NE-NW and also SE-NE, sec. 23, T 28 N, R 28 W), where an excellently preserved insect fauna was found. At this locality algal beds occur respectively below and above the two insect beds. Equivalent algal beds were traced to Sumner County, Kan. (SE-SW, sec. 11, T 35 S, R 1 W). Insects were found associated with the upper algal bed.

This is the first stratigraphically related correlation of the Oklahoma and Kansas Wellington formation. As a result, dozens of fossil conchostracan beds that Tasch found in the Oklahoma Wellington can be related to those discovered in Kansas. This, in turn, provides the necessary stratigraphic basis for study of evolutionary changes in Permian conchostracans.

Previous work by Tasch in Kansas (*3*) established that there were two distinct insect beds: the well-known Carlton insect bed of Dunbar in Dickinson County and one below it in Marion, Harvey, and Sedgwick counties. The Midco insect bed and the newly discovered insect bed above it are stratigraphically above (that is, geologically younger than) the two insect beds of Kansas. Thus, four distinct insect beds are now known for the mid-continent Wellington formation.

Fossil Permian insects belonging to the following orders and families have been identified by Zimmerman, who is doing the insect systematics for this project.

Southern Kay County, Okla. Upper insect bed, 8 ft above the Midco: Protodonata; Odonata, Protozygoptera, Kennedyidae, *Kennedya* sp.; Protoperlaria, Lemmatophoridae.

*Northern Kay County, Okla.* Upper insect bed, 9.9 ft above the Midco: Ephemeroptera. Mideo: (extinct orders) Protodonata, Megasecoptera, Protelytroptera, Protoperlaria, Protorthoptera; (living orders) Ephemeroptera, Odonata, Blattaria, Corrodentia, Homoptera, Neuroptera, Mecoptera.

*South Haven, Sumner County, Kan.* Upper algal-insect bed, 9.3 ft above the Midco equivalent: Megasecoptera.

These findings are of unusual interest. Our knowledge of insect speciation and evolutionary trends during the American Permian had previously been limited to data from two beds: Midco and Carlton. Extension of the vertical range of Leonardian insects—above the Midco and below the Carlton—enlarges the geologic time span through which they may now be studied (*4*).

PAUL TASCH
*Department of Geology, University of Wichita, Wichita, Kansas*
JAMES R. ZIMMERMAN
*Department of Biology, Indiana Central College, Indianapolis*

**References and Notes**

1. G. O. Raasch, thesis, University of Wisconsin (1946).
2. F. M. Carpenter, *Proc. Am. Acad. Arts Sci.* **76**, 25 (1947).
3. P. Tasch, "Stratigraphic position of the Wellington conchostracan-bearing beds in Kansas," *Abstr. AAPG-SEPM Program, Dallas meeting* (1959), p. 60.
4. This research was supported by National Science Foundation grants Nos. G-7320 and G-4150.

31 August 1959

## All-Female Strains of the Teleost Fishes of the Genus Poeciliopsis

*Abstract.* In addition to the viviparous fish *Mollienesia formosa,* two other species of poeciliids have recently been found to produce only female offspring. The young of these females, however, unlike those of *M. formosa,* inherit characteristics from any one of the several species of males used in experimental matings.

Self-perpetuating populations of unisexual vertebrates have been experimentally demonstrated only among the viviparous fishes of the New World family Poeciliidae—of which the guppy

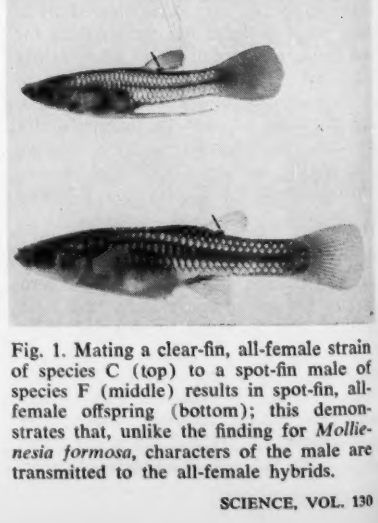


Fig. 1. Mating a clear-fin, all-female strain of species C (top) to a spot-fin male of species F (middle) results in spot-fin, all-female offspring (bottom); this demonstrates that, unlike the finding for *Mollienesia formosa,* characters of the male are transmitted to the all-female hybrids.

(*Lebistes reticulatus*) is perhaps the most widely known representative. Nearly 30 years ago Hubbs and Hubbs (*1*) announced the discovery of a remarkable fish which has only one sex. This is the so-called Amazon molly (*Mollienesia formosa*), which inhabits coastal and inland waters of northeastern Mexico and adjacent Texas. These females are able to maintain themselves as natural populations by utilizing the males of *M. sphenops* in certain parts of their range and the males of *M. latipinna* in others. Fourteen years of experimental work has demonstrated that this species, evidently of hybrid origin, produces daughters only, and that these are invariably like their mothers despite the fact that the mothers were mated with the males of many related species, including even the guppy. Development is clearly induced by sperm, though no evidence of paternal inheritance has been found in resulting generations. These authors subsequently concluded (*2*) that "the most plausible explanation for the genetic behavior of *Mollienesia formosa* is that this unisexual species is a permanently fixed diploid," and that active sperm is essential to initiate embryonic development (gynogenesis).

Recently Hubbs, Drewry, and Warburton (*3*) reported the discovery of what they interpreted as a naturally occurring phenotypic male of *M. formosa* in a population of this species taken near Brownsville, Tex. We and others (*4*) feel, however, that it is quite possible that *M. sphenops* is occasionally liberated near Brownsville by aquarists or tropical-fish fanciers, or that it may occur there naturally on occasion. If so, the "male of *M. formosa*" may actually be a hybrid between *sphenops* and *latipinna*, which readily cross in aquaria and produce bisexual offspring. Only experimental evidence can reveal the correct explanation.

At this time we wish to announce the discovery of unisexual types in two other species belonging to the same family as *M. formosa*. These, members of the genus *Poeciliopsis*, inhabit coastal streams of northwestern Mexico. Unlike the Amazon molly, these two allopatric species each have two kinds of females —those which produce both sexes and those which, although mated to the same male as the former, produce daughters only. Four generations of these fishes have been reared in the laboratory, with consistent production of bisexual young from the "normal" females and of unisexual offspring from the "aberrant" females.

The "all-female" strains of the two species of *Poeciliopsis* (here referred to as *F* and *C*) were discovered by chance, since they are virtually indistinguishable from the normal females. A slight but consistent difference in dentition noted in preserved specimens first revealed the existence of two types of females in F and subsequently led to the studies now in progress (*5*). On similar grounds, the unisexual strain of C was later predicted and its occurrence has recently been verified.

Although the genetic explanation of these remarkable strains is not yet clear, sufficient data have accumulated to indicate that this all-female condition is not the result of (i) a sex-linked lethal, (ii) parthenogenesis, (iii) gynogenesis, (iv) cytoplasmic inheritance, or (v) sex reversal. We have established on the basis of genetical evidence that these fish have sex chromosomes and that, unlike most other viviparous fishes, the female is heterogametic and the male homogametic. Using marker genes, we have been able to show that paternal traits of the male of F are transmitted through the all-female of C to the $F_1$ hybrid (Fig. 1).

These unisexual strains are of interest as possibly representing a transitional stage in the development of an all-female form like that of *M. formosa*.

ROBERT RUSH MILLER
R. JACK SCHULTZ
*Museum of Zoology,*
*University of Michigan, Ann Arbor*

**References and Notes**

1. C. L. Hubbs and L. C. Hubbs, *Science* **76**, 628 (1932).
2. ———, *Records Genet. Soc. Am.* **14**, 48 (1946).
3. C. L. Hubbs, G. E. Drewry, B. Warburton, *Science* **129**, 1227 (1959).
4. C. Hubbs, personal communication, 1958; C. P. Haskins, personal communication, 1959.
5. Since 1955 these studies have been supported by grants from the Horace H. Rackham School of Graduate Studies, University of Michigan, and, since 1958, by a grant from the National Science Foundation (NSF G-4854).

6 August 1959

## Wave-Riding Dolphins

I wish to take issue with P. F. Scholander (*1*) on the problem of how dolphins ride waves (*2*). The problem of wave-riding dolphins was posed by Woodcock (*3*) and by Woodcock and McBride (*4*), who estimated the hydrodynamics of a dolphin riding a wave propelled by its own weight times the angle (in radians) of the wave. Woodcock and McBride showed that with a reasonable estimate of the hydrodynamic drag, the submerged weight of the dolphin was insufficient to provide the necessary balancing thrust. I resolved the problem by showing that it is the total weight of the dolphin, rather than its submerged weight, which is significant in wave riding.

Fig. 1. Forces on the dolphin in Scholander's model.

Scholander has rejected my explanation and has substituted an explanation of his own for the phenomenon. In my opinion Scholander has discarded a satisfactory and rational explanation to substitute one which violates fundamental physical laws.

Scholander's criticism of my explanation (*5*) appears to involve some lack of understanding of this explanation. In the critical part of his discussion of it Scholander confuses the concepts of acceleration and velocity. Here I must admit that my earlier article was written in quite a terse style. Though the article states the argument completely, it includes little expositional detail and might be fully convincing only to a theoretical hydrodynamicist willing to supply this detail. The conclusions of the article are nonetheless sound: A streamlined body in a steady incompressible flow does experience a force very nearly equal to its volume times minus the average ambient pressure gradient in the flow field. This effect provides the dolphin with a net forward thrust approximately equal to its displaced weight times the wave angle. Scholander admits that his experiments testing this effect do not represent a fair evaluation, and he gives but little description of them.

The principle of a hydrodynamic force proportional to the ambient pressure gradient is an old one and plays a part in classical aerodynamics. [See, in particular, the work of Taylor (*6*).] Taylor's paper gives not only a thorough theoretical treatment but also a description of experimental verification of the basic effect. The additional induced mass over the displaced mass is small for a slender body, and was neglected in my earlier article (*5*).

Scholander's alternative explanation is based upon a model, in which the dolphin derives a large upward force *F* on its tail fluke (see Fig. 1). The tail fluke is in a part of the wave in which the water is rising, with the result that the upward force has an appreciable forward component which balances the drag on the dolphin. So far, Scholander's model is satisfactory. The difficulty lies in the fact that both horizontal and vertical components of the forces on the dolphin must balance, and so must the

moments. These conditions are required by classical statics. In Scholander's model the horizontal force components balance, but the vertical components clearly do not balance. If we suppose that the dolphin also develops a large downward force on its flippers in the region in front of the wave, so that the vertical force components balance, the moments clearly do not balance. The inescapable conclusion is that Scholander's model is not a possible one. In this light it is also clear that the experiment described by Scholander is not a pertinent one, because of the vertical reaction at the pivot of the support arm.

WALLACE D. HAYES
*Princeton University,*
*Princeton, New Jersey*

**References and Notes**

1. P. F. Scholander, *Science* **129**, 1085 (1959).
2. I am indebted to Scholander for sending me, through W. H. Munk, a copy of his article in advance of publication. The criticisms of the present note were submitted (again through Munk) to Scholander in private correspondence, but they were insufficient to induce him to withdraw his article from publication.
3. A. H. Woodcock, *Nature* **161**, 602 (1948).
4. ——— and A. F. McBride, *J. Exptl. Biol.* **28**, 215 (1951).
5. W. D. Hayes, *Nature* **172**, 1060 (1953).
6. G. I. Taylor, *Proc. Roy. Soc. (London)* **A120**, 260 (1928).

13 May 1959

Eleven years ago Woodcock observed that a dolphin gets a free ride when in close proximity to the bow of a ship. In this situation the body of the dolphin rides in the horizontal water ahead of the bow—that is, it is not located within a wave. Only the tail fluke engages the disturbed water. This essential point was missed by both Woodcock and Hayes, who instead proceeded to explain an imaginary, unobserved situation where a dolphin supposedly gets a free ride in the front slope of a wind wave. With both dolphins and theories missing the boat, so to speak, it is no wonder that the observed bow-riding phenomenon remained unsolved.

Interesting, notwithstanding, is the thesis held by Hayes—namely, that a streamlined body of neutral bouyancy

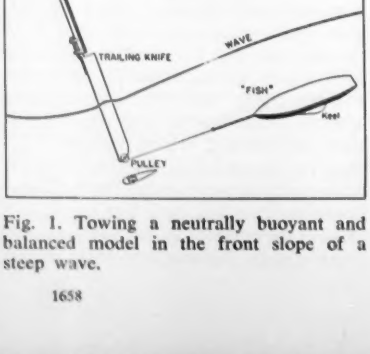



Fig. 1. Towing a neutrally buoyant and balanced model in the front slope of a steep wave.

can be propelled within a wave at wave velocity. To most of my colleagues this seemed unrealistic, and with the authorities clearly split, the only way out was to test the idea experimentally. Standing on a dock one may easily observe that neutrally buoyant fish or pieces of seaweed in any orientation are not swept along with the waves passing by. The issue therefore narrows down to the question: Can the Hayes effect, if indeed it exists, maintain or assist a propulsion at wave velocity once such a propulsion has been started?

The following experiments were designed to test this. A skiff at the end of a rope 20 m long was towed from the tip of the transversely secured boom of one of the Scripps Institution research ships. By careful steering it was possible to maintain the skiff in a fixed relation to the waves coming off the side of the ship. Streamlined and neutrally balanced models were towed at four positions within these smooth and relatively very steep waves (Fig. 1). With the wave angle some 30° and the model weighing 650 gm, the Hayes effect would amount to some 300 gm. It can be seen from Fig. 2 that the drag merely reflected the relative velocity between the water and the model, being least in the crest, largest in the trough, and intermediary in the slopes. There is no indication whatever of a 300-gm push in the front slope (or of an added 300-gm drag in the back slope).

As pointed out in my original article, better data can certainly be obtained, but even now it seems clear that if Hayes, like myself, caters to the judgment of the multitude, he must come down to an experimental defense of his thesis. If through a more refined technique he can demonstrate that my relatively crude results are misleading, then I shall gracefully bow out, happy all the while to have contributed to a better understanding of what goes on in a wave. At present, however, Hayes' basic thesis is challenged by many and stands contradicted by experimental evidence (*1*).

Now, to return to the main issue—namely, the relationship between the dolphin's tail and the curvaceous bow of the ship. Hayes is eminently right when he echoes my concern that the situation, as outlined in his Fig. 1, theoretically is not a stable one; for in tending to topple over, the dolphin will slide back and out of position. So much for the theory, but in the actual fact he remains right there. We ourselves can beautifully handle unstable conditions, like standing upright, and no doubt the porpoise is equally proficient in similar control functions. If the dolphin in Hayes' diagram slides forward relative to the bow wave, the front edge of the tail fluke will soon catch horizon-

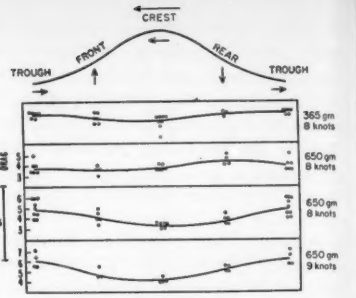



Fig. 2. Drag measurements in the trough, front, crest, and rear slope of a wave. Each point is a single reading. The short arrows in the wave profile indicate the direction of movement of the water particles. The large horizontal arrow indicates the direction of wave propagation.

tal water. This will depress the fluke against the rising water behind, with consequent propulsive effect. Perhaps some such scheme can be made to balance out. I shall confess, however, that my feeble attempts to show this experimentally have met with failure, so again we must bow to the dolphin. How, also, can a dolphin swim several times faster than predicted from drag and muscle power? This is another problem which has long amused physiologists but has rather worried students of theoretical fluid mechanics.

When playing around in the ocean, dolphins are pleasing to the eye no end, but let it only add to your thrill that these rascals are a graveyard to our wits. For is not finding out infinitely more exciting than knowing the answer?

P. F. SCHOLANDER
*Scripps Institution of Oceanography,*
*La Jolla, California*

**Note**

1. For bibliography see the preceding report by Hayes.

4 September 1959

## Carbon Isotope Fractionation in Bacterial Production of Methane

*Abstract.* Anaerobic bacteria from a Pacific Ocean mud cause unusually large carbon isotope fractionations during fermentation of methanol. The methane produced is about 8 percent enriched in $C^{12}$, relative to the original methanol. Fractionation factors determined at 30°C and 23°C were 1.081 and 1.094, respectively, which indicates that this process is dependent on temperature.

Bacterial fractionation of stable isotopes has been reported for sulfur (*1*) and hydrogen (*2*). Recent studies at this laboratory have revealed that an unusually large carbon isotope frac-

tionation occurs during the bacterial production of methane. Because of the importance of bacteria to the carbon cycle, this process is being studied in some detail. The first reaction investigated was the anaerobic conversion of methanol to methane, which is believed to proceed as follows (*3*):

$$4CH_3OH \rightarrow 3CH_4 + CO_2 + 2H_2O$$

The methane-producing culture used in this study was developed from a deep-sea mud cored in the northern Pacific Ocean (*4*). The culture was produced by enrichment with methanol and was grown in 16-by-125-mm screw-capped glass tubes at 23°C and at 30°C. Pure-culture study was not attempted, but a crude enrichment was achieved by serial transfer of the culture ten times at 2- to 4-day intervals before gas collections were made. Analyses were performed on gases produced by cultures growing in 600-ml Fenwal flasks completely filled with medium. The basal medium contained inorganic salts (*5*) dissolved in a mixture of three parts of synthetic sea water (*6*) to one part of distilled water. After sterilization of the medium at 122°C for 20 minutes, sufficient reagent-grade methanol was added to give a 0.10*M* concentration. To promote anaerobiosis, 0.03 percent $NA_2S{\cdot}9H_2O$ was added before inoculation with 30 ml of an actively growing culture. The flasks were fitted with rubber stoppers through which the evolved gases were conducted via stainless-steel hypodermic fittings and polyethylene tubing to glass collection vessels filled with saturated NaCl solution.

Gas composition was determined with a Perkin-Elmer model 154 vapor fractometer. No attempt was made to recover or measure the carbon dioxide dissolved or precipitated in the culture medium during bacterial growth. The $CH_4$ and $CO_2$ fractions of the evolved gases were separated by condensing the $CO_2$ with liquid nitrogen. The $CH_4$ fraction was converted to $CO_2$ by established combustion procedures (*7*). The carbon dioxide formed by combustion of $CH_4$ and that produced during fermentation were analyzed separately in a modified Nier isotope ratio mass spectrometer (*8*) capable of measuring $C^{13}/C^{12}$ ratios to a precision of ±0.1 per mil (0.01 percent). These analyses are reported as permillage deviations (δ-values) of the $C^{13}/C^{12}$ ratios of the samples from that of the $CO_2$ prepared from a special petroleum standard. The δ-value of this standard is −29.4 per mil relative to the Peedee belemnite standard used at the University of Chicago (*9*). The reported values have been corrected for the $O^{17}$ contribution to the mass-45 beam intensity (*9*).

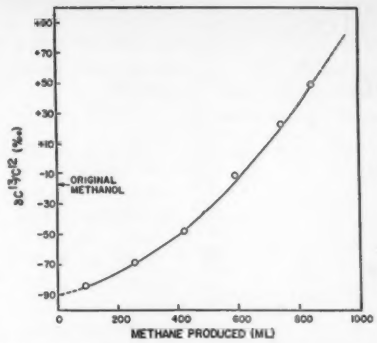



Fig. 1. Changes in the carbon isotope ratio of methane produced by the bacterial fermentation of 0.10*M* methanol at 30°C.

Table 1. Volume yields and compositions of gases produced from 0.10*M* methanol ($\delta C^{13}/C^{12}$ of original methanol is −16.3 per mil) by bacterial fermentation at 30°C.

| Time (day) | Methane | | Carbon dioxide | |
|---|---|---|---|---|
| | Vol. (ml) | $\delta C^{13}/C^{12}$ (per mil)* | Vol. (ml) | $\delta C^{13}/C^{12}$ (per mil)* |
| 4 | 183 | −83.8 | 15 | |
| 8 | 146 | −68.6 | 14 | −1.2 |
| 12 | 182 | −47.8 | 22 | −3.8 |
| 15 | 162 | −10.9 | 13 | |
| 21 | 142 | +23.5 | 22 | +11.1 |
| 25 | 63 | +49.9 | 5 | |

*$\delta C^{13}/C^{12}$ in permillage:

$$\frac{C^{13}/C^{12}_{\text{sample}} - C^{13}/C^{12}_{\text{standard}}}{C^{13}/C^{12}_{\text{standard}}} \times 10^3$$

Cultures grown at 30°C in a medium containing a 0.10*M* concentration of methanol produced 85 percent of the theoretical methane yield after 25 days. Chemical and isotopic analyses of the gases produced are shown in Table 1. Incomplete recovery of $CO_2$ is believed to have resulted from its retention in the medium by solution and by formation of calcium and magnesium carbonates (the medium contained 0.09 percent $CaCl_2$ and 0.37 percent $MgCl_2$). Compared with the original methanol, which has a $C^{13}/C^{12}$ δ-value of −16.3 per mil, the δ-values shown in Table 1 indicate that the methane produced by this fermentation is highly enriched in $C^{12}$. The extent of $C^{12}$ enrichment is indicated by the plot (Fig. 1) of $C^{13}/C^{12}$ δ-values against the volume of methane produced. As $C^{12}$-enriched methane is produced during fermentation, residual undecomposed methanol necessarily becomes enriched in $C^{13}$. The progressively increasing $C^{13}/C^{12}$ ratio of the methane released reflects this enrichment. The $C^{13}/C^{12}$ δ-values given in Table 1 were determined for finite gas volumes; they represent, therefore, the average isotope ratios of each volume of gas collected. Accordingly, in the graph shown in Fig. 1, isotope ratios are plotted against half of the volume of methane produced. Extrapolation of this curve to zero gas volume gives a δ-value of −90 per mil, from which we have computed a fractionation factor of 1.081 (*10*) for $C^{12}$ enrichment in $CH_4$ relative to the original methanol at the start of fermentation. The data indicate also a large isotopic disproportionation between the $CH_4$ and $CO_2$ produced; the $CO_2$ tends to be higher in $C^{13}$ content than the $CH_4$. A quantitative estimate of the carbon isotope distribution between these products was not possible because of incomplete recovery of $CO_2$ produced.

The experiment was repeated at the same temperature (30°C) with a higher concentration of methanol (0.25*M*) in the medium. Results obtained under these conditions were similar to those with 0.10*M* methanol, and a fractionation factor of 1.083 was computed from these data. The fractionation factor increased to 1.094 in another culture grown on 0.25*M* methanol at 23°C, indicating that this $C^{12}$ enrichment process is dependent on temperature.

These bacterial enrichments of light carbon ($C^{12}$), which are of the order of 8 percent, represent the highest natural carbon isotope fractionations yet reported.


WILLIAM D. ROSENFELD
SOL R. SILVERMAN
*California Research Corporation, La Habra, California*


### References and Notes


1. A. G. Harrison and H. G. Thode, *Trans. Faraday Soc.* **54**, 84 (1958); G. E. Jones and R. L. Starkey, *Science* **123**, 1124 (1956).
2. P. E. Cloud, Jr., I. Friedman, F. D. Sisler, V. H. Dibeler, *Science* **127**, 1394 (1958); F. D. Sisler, *Science* **129**, 1288 (1959).
3. T. C. Stadtman and H. A. Barker, *J. Bacteriol.* **61**, 81 (1951).
4. Marine muds were obtained through the cooperation of Prof. C. E. ZoBell and Dr. G. E. Jones of the Scripps Institution of Oceanography, University of California, La Jolla.
5. T. C. Stadtman and H. A. Barker, *J. Bacteriol.* **61**, 67 (1951).
6. Sea water was made according to the formula of Lyman and Fleming as tabulated in H. U. Sverdrup, M. W. Johnson, R. H. Fleming, *The Oceans* (Prentice-Hall, Inc., New York, 1942), p. 186.
7. H. Craig, *Geochim. et Cosmochim. Acta* **3**, 53 (1953); S. R. Silverman and S. Epstein, *Bull. Am. Assoc. Petrol. Geologists* **42**, 998, (1958).
8. C. R. McKinney *et al.*, *Rev. Sci. Instr.* **21**, 724 (1950).
9. H. Craig, *Geochim. et Cosmochim. Acta* **12**, 133 (1957).
10. The fractionation factor ($k$) for depletion of $C^{13}$ (enrichment of $C^{12}$) is determined from the expression:

$$\delta C^{13}/C^{12}_{\text{methane}} - \delta C^{13}/C^{12}_{\text{methanol}} = (1 - k)\ (\delta C^{13}/C^{12}_{\text{methane}} + 1000).$$


3 August 1959

*Book Preview*

**SPORES—FERNS**

**MICROSCOPIC ILLUSIONS**

• • •

New 3-D. approach

Finest existing collection

**MODELS—PHOTOMICROGRAPHS**

**Spores—Tetrad to Maturity**

**Fertile Areas • Cell Structure**

See our Exhibit Booth 71, AAAS Convention

• • •

**MISTAIRE LABORATORIES**

152 Glen Ave., Millburn, N. J.

**GRASSLANDS**

**Editor: Howard B. Sprague** **1959**

**6″ x 9″, 424 pp., 37 illus., index, cloth. Price $9.00, AAAS members' cash orders $8.00. AAAS Symposium Volume No. 53.**

This volume is intended as a review of knowledge on many aspects of grasslands resources. The 44 authors were selected by their own professional colleagues as being particularly competent to present the respective subjects. Thirty-seven papers are arranged under these chapter headings:

1. Sciences in Support of Grassland Research
2. Forage Production in Temperate Humid Regions
3. Engineering Aspects of Grassland Agriculture
4. Forage Utilization and Related Animal Nutrition Problems
5. Evaluation of the Nutritive Significance of Forages
6. Grassland Climatology
7. Ecology of Grasslands
8. Range Management

**British Agents: Bailey Bros. & Swinfen, Ltd., Hyde House, W. Central Street, London, W.C.1**

**AAAS, 1515 Mass. Ave., NW, Washington 5, D.C.**

# Meetings

## Glucuronic Acid Research

The study of glucuronic acid in relation to many fields of biology and medicine has been a major continuing activity of Japanese investigators. This interest developed first from the work on the metabolism of drugs in which glucuronic acid conjugation is a frequently encountered feature, and then, with the ready availability of pure glucuronic acid (Chugai Pharmaceutical Company, Tokyo), from a widespread curiosity to examine its biological properties in almost every living situation. A measure of the magnitude of this research effort is the fact that for the last 4 years a research conference on this subject has taken place. I was privileged to be invited to attend the fifth Glucuronic Acid Research Conference which was held 2 and 3 June at Sankei Kaikan, Tokyo. At this conference and on a number of other visits in June to research laboratories in Japan, it was possible to exchange views and to acquire information regarding biochemical studies on glucuronic acid. My present purpose is to transmit this knowledge to American investigators who are working in this area of research.

The conference was opened by M. Ishidate, dean of the faculty of pharmaceutical sciences, University of Tokyo. It was attended by some 250 investigators invited from many research centers of Japan. Two novel features of the meeting were, first, the simultaneous use of two slide projectors and two screens to expedite illustration of the data, and second, the provision of a pocket radio transmitter which not only freed the speaker from the electrical wires which ordinarily chain him to the podium but gave pleasing sound amplification.

Forty-four original papers were presented. Thirteen were concerned with the biochemistry and physiology of glucuronic acid, four with its growth-promoting effect, twelve with detoxication of drugs, viruses, and toxins, and the remainder with the clinical use of glucuronic acid.

### Biochemistry and Physiology

The conjugation of amines with glucuronic acid and the significance of this process was reported by Ishidate. Aromatic and aliphatic primary amines easily form N-glucuronides at room temperature in the presence of aqueous solutions of glucuronic acid or its alkaline salts. Crystalline N-glucuronides have been obtained of the following: aniline, toluidine, *p*-chloroaniline, monoacetyl-*p*-phenylenediamine, *p*-dimethylaminoaniline, *p*-phenylenediamine, sulfanilamide, sulfapyridine, benzylamine, β-phenylethylamine, ethylamine, isopropylamine, isobutylamine, and cyclohexylamine. A quantitative relation between amine metabolism and glucuronic acid excretion was observed when rabbits were given aniline, sulfanilamide, or sulfapyridine. Also, after the administration of *p*-dimethylaminoazobenzene to dogs, one of the urinary metabolites appeared to be the N-glucuronide of *p*-mono-methylaminoazobenzene. The studies have included the property of amino acids to form N-glucuronides. These can be detected by paper chromatography but, because of their lability, they have not yet been isolated. A reaction of glucuronic acid with diphtheria toxin takes place at *p*H 7.0 and 38°C with the gradual disappearance of toxicity. The formation of antiserum from the injection of this material was no different than in the case of formalin-inactivated toxin. It was therefore suggested that an amino group is the functional group of toxin and that this reaction depends upon formation of an N-glucuronide.

Ishidate then reviewed the two mechanisms which can explain glucuronic acid conjugation (UDPGA, β-glucuronidase) and found that information regarding the enzymatic mechanism of formation of N-glucuronide is incomplete.

Shimazono *et al.*, (department of biochemistry, University of Tokyo) reported that incorporation of phosphate into rat liver tissues was increased by the injection of D-glucuronate. From an analysis of fractions containing nucleotides and sugar phosphates, it was stated that this incorporation was most marked in the case of glucose-6-phosphate and *d*-glycerophosphate. In a carefully done enzymatic study of glucuronic acid, the following observations were made. D-Glucuronate was reduced to L-gulonate by TPN-gulonic dehydrogenase, and L-gulonate was oxidized following decarboxylation to L-xylulose by DPN-gulonic dehydrogenase. The formation of lactone from D-glucuronate or L-gulonate by soluble lactonase from cell supernatant was observed with the aid of hydroxylamine. The lactonase which acts on D-glucuronolactone was present in liver microsomes of various animals but not in human and monkey liver. L-Gulonolactone was formed easily from D-glucuronolactone by the action of TPN-gulonic dehydrogenase. A dehydrogenase present in microsomes produces ascorbate from L-gulonolactone.

Much discussion centered around in vivo effects of administered glucuronic acid in relation to carbohydrate metabolism, particularly in the liver. Thus,

# Kodak reports on:

**"Ektalith," a word which will catch on . . . the stable basis of photography . . . four views of a 1920 Bavarian postage stamp . . . the nylon rope trick**

## Camera weds duplicator

There are many thousands of offset duplicators in offices. We have worked out new materials and equipment which enable them to start in two minutes turning out in quantity first-rate enlargements or reductions of anything drawn, written, or printed, including microfilm records. If you require relatively few copies, you don't even need an offset duplicator. Write a note to Eastman Kodak Company, Graphic Reproduction Division, Rochester 4, N. Y., and ask where in your locality you can see a demonstration of the *Kodak Ektalith Method.*

## Wall Street cheery

> ***Factory Photos***
>
> Firms Spur Camera Use
> To Solve Test, Sales,
> Production Problems

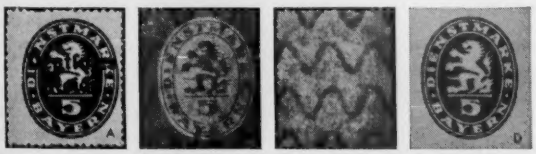
headlined the first column of *The Wall Street Journal* on the penultimate morning of last summer.

"Industry sources expect retail sales of equipment and supplies for industrial photographic use will reach some $250 million this year, up from about $100 million five years ago," the story said. (That's a very short time ago. These very discourses have been appearing for six years in this periodical.)

Feeling well disposed toward *The Wall Street Journal*, we laid it aside and took action to maintain the trend. Of "supplies" that *The Wall Street Journal* mentioned, none is older than photographic plates—our original product. For the love of challenge, we decided to get ready for the printer a chart that would put the photographic plate right into the spearhead of photography's onslaught on current technology.

*The chart is now ready. You may have a copy with our compliments for your photo department wall. Indicate interest to Eastman Kodak Company, Special Sensitized Products Division, Rochester 4, N. Y. It takes 29" x 16½" to set out enough information about our 75 species of plates to permit industry and technology some intelligent basis for choice. You will receive the chart accompanied by a little pamphlet on dimensional stability entitled "Physical Characteristics of Kodak Glass Plates." Gist of the pamphlet's message: if there were no such thing as the glass photographic plate, it would be necessary to invent it.*

## About the new x-ray films

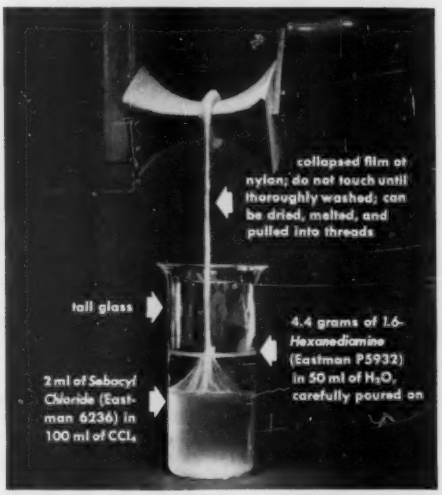


**Bavarian stamp of 1920 (Scott No. 052). A. Visible light photograph. The design is green and the "Deutsches Reich" overprint is black. B. Soft x-ray radiograph. Details of both design and paper visible. Design is "negative," indicating absorption of x-rays by the ink. C. Electron radiograph. Only the details of the paper are shown. D. Electron-emission radiograph. The design is "positive," indicating a relatively high electron emission from some heavy element in the ink. The overprint cannot be seen.**

This is a clever scheme to snare the attention of those who use philately for a hobby and radiation for a livelihood. Having gained your attention, we must reward you for it. The reward takes the form of a handsome 24-page book which contains not only a discussion of the above illustrations but (much more important) of general techniques for radiography by emitted electrons, transmitted electrons, soft x-rays, hard x-rays, and gamma rays; and (most important) operating data about the several new and newly improved Kodak films for all manner of radiography and x-ray diffraction.

*Request a copy of the* Second Supplement *to "Radiography in Modern Industry" from Eastman Kodak Company, X-ray Division, Rochester 4, N. Y. To have it make full sense, it helps to have a copy of the book that the supplement supplements. This hard-cover, thoroughly indexed, 136-page affair is sold by x-ray dealers for $5. If you already own it and have sent in the postcard that came with it, you doubtless have already received and read the supplement and have been wasting your time for the past 90 seconds.*

## A polyamide condensation for the kids to watch but keep their little hands off


collapsed film of nylon; do not touch until thoroughly washed; can be dried, melted, and pulled into threads
tall glass
4.4 grams of 1,6-Hexanediamine (Eastman P5932) in 50 ml of $H_2O$, carefully poured on
2 ml of Sebacyl Chloride (Eastman 6236) in 100 ml of $CCl_4$

Du Pont, which doesn't ordinarily manufacture its nylon this way, was kind enough to publish this in *J. Chem. Education 36*, 182. We have been kind enough to prepare an abstract. Price for our minimum package quantities of the two reactants comes to $6.05. Teachers and Yuletide-bent daddies are reminded of the insidious nature of chlorinated hydrocarbons. Anyone inspired to commercial thoughts is advised to consult with his lawyer about U. S. Patent No. 2,708,617. Everyone who wants these or any of the approximately 3700 organic chemicals we stock (and catalog in Eastman Organic Chemicals, List No. 41) should get in touch with Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company).

*Prices quoted are subject to change without notice.*

**This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science**

Kodak
TRADE MARK

Obara *et al.* drew attention to effects on the adrenal gland; Oda and Hara observed an increase in liver glycogen following glucuronolactone or xylulose injection; Imanaga stated that the increase in blood ammonia in patients with a portacaval shunt can be controlled with exogenous glucuronic acid; Oji studied urinary pentose in patients with liver disease and in animals with $CCl_4$ poisoning; Kobayashi *et al.* investigated the effect of glucuronic acid on experimental diabetes mellitus; Kurokawa and Yamagata reported experimental and clinical studies on a beneficial effect of glucuronic acid in diabetes; Masuda *et al.* investigated phosphorus metabolism in the liver of rabbits given carbon tetrachloride; and Kusuya *et al.* studied the effect of glucuronic acid on sugar assimilation.

With regard to β-glucuronidase, Tsukamoto *et al.* of Kyushu University proposed the use of *p*-nitrophenyl glucuronide as a substrate for both the hydrolytic and transfer activities of the enzyme. The enzyme was stated to catalyze the formation of *m*-aminophenyl glucuronide in a system in which benzoyl glucuronide was the donor substrate, and *m*-aminophenol, the acceptor molecule.

Now . . .

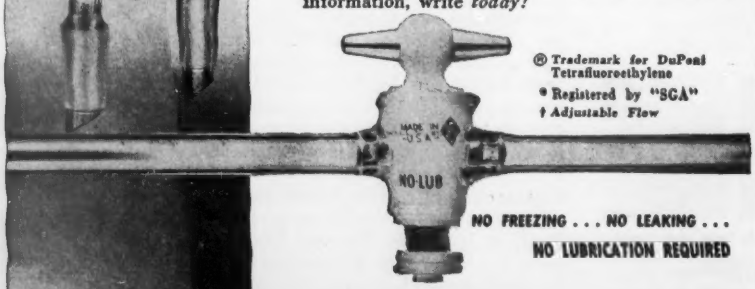
GYCO STOPCOCKS

feature *Adjustable Flow*—
at no extra cost!

other major features . . .
TEFLON® plug with 1:5 taper
NO-LUB* glass barrel

At last—a stopcock that permits you to control the flow easily . . . from ultra-fine adjustment to full discharge! A slight turn of the plug handle reduces the flow for accurate titration or precise shut-off at any given point. Gyco Stopcocks with "AF†" plugs completely eliminate the need for special attachments and cumbersome needle valves.

All future Gyco Stopcocks, except those with 120° bore or "T" bore, will be supplied with the new "AF†" feature—the result of a recently-designed Teflon plug with unique bore. The entire Gyco Stopcock line is listed in Combined Catalog 59; also in "What's New for the Laboratory" No. 35. If you do not have complete information, write *today!*




® Trademark for DuPont Tetrafluoroethylene
* Registered by "SGA"
† Adjustable Flow

NO FREEZING . . . NO LEAKING . . .
NO LUBRICATION REQUIRED

SCIENTIFIC GLASS APPARATUS CO. INC.
BLOOMFIELD, NEW JERSEY

LABORATORY . . .
♦ APPARATUS
♦ INSTRUMENTS
♦ CHEMICALS
♦ GLASSWARE

Branch Sales Offices: Albany 5, N. Y. • Boston 16, Mass. • Elk Grove Village, Ill. • Philadelphia 43, Pa. • Silver Spring, Md.


### Growth-Promoting Effects

Several papers were presented which illustrate the variety of investigations into growth-promoting effects. Thus, Ogawa (National Institute of Genetics) observed that sodium glucuronate and glucuronic acid showed a significant growth-promoting effect on the early development of the embyro (*Triturus pyrrhogaster*) which was most prominent on the 13th day after fertilization (stage 32); Tamura (Tokyo Dental College) noted that the growth of chicks on a vitamin-B-deficient diet was promoted by glucuronolactone; and Wada *et al.* (Sapporo Medical College) reported that the prior administration of glucuronolactone to rats significantly promoted the growth of intraperitoneally transplanted Yoshida sarcoma cells, whereas the opposite effect occurred on the growth of subcutaneously transplanted Yoshida sarcoma.

### Experimental and Clinical Studies on "Detoxication"

Although the papers on clinical and detoxication studies were the most numerous, yet, because of the great variety of conditions investigated they were not amenable to generalization.

The effect of exogenous glucuronic acid on the excretion of morphine glucuronide was thoroughly investigated by Hosoya and Otobe (Keio University School of Medicine). Thus, during the first 2 hours after administration of morphine, bound morphine appears earlier and in larger amounts in the urine of rabbits receiving glucuronic acid and morphine. Hosoya stated that these results seemed to indicate that exogenous glucuronic acid accelerates conjugation of morphine with glucuronic acid in the living body although it was by no means clear whether the exogenous glucuronic acid did conjugate with endogenous glucuronic acid by some unknown mechanism.

Shirai *et al.* (Kobe Medical College) extended his observations on the ethyl ester of glucuronic acid which augmented the formation of anthranilic acid glucuronide in the rabbit. He observed that the glucuronic acid ester is excreted in the urine more slowly than glucuronolactone.

Sawada (Kyushu University) stated that the direct-reacting bilirubin in cat bile was the glucuronide but that this substance was not produced by cat liver microsomes fortified with UDPGA.

Examples of the experiments and of the toxic compounds studied are Takahashi's (Kyoto) perfusion studies of conjugation by livers damaged with carbon tetrachloride; Tsumoo's (Showa Medical College) study of the effect of 1-phenyl-2-methylaminopropane and ephedrine on blood pressure and respiration in the urethanized rabbit; Tanuora's

# NEW! FAST

## MICROSCOPIC SLIDE LABELING

Fast—convenient and accurate! Simply pull tab and label "pops" out. The pressure-sensitive labels are dispensed one at a time and are available in two sizes; standard and "tissue-high" thickness. They accept pen, pencil, ball point or typewriter marking. 1000 labels per carton in 3/8" x 7/8" or 7/8" x 7/8" plain or pre-printed.

TIME SELF-STICKING LABELS VINYL COATED

Write for detailed information and the name of your nearest TIME distributor.

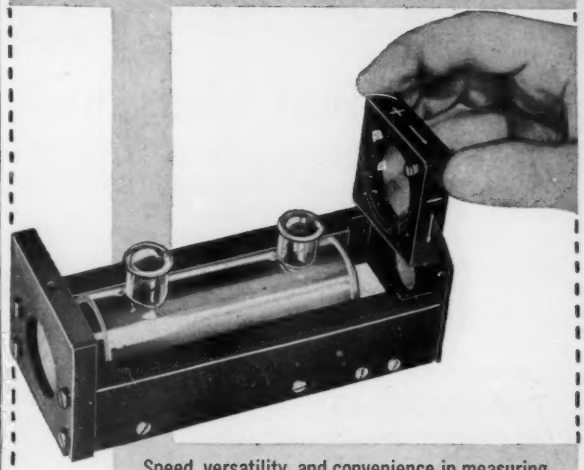
**PROFESSIONAL TAPE CO., INC.**
355 Burlington Ave. • Riverside, Ill.

---

PHOTOVOLT Photoelectric

# POLARIMETER

LUMETRON Model 402-EP



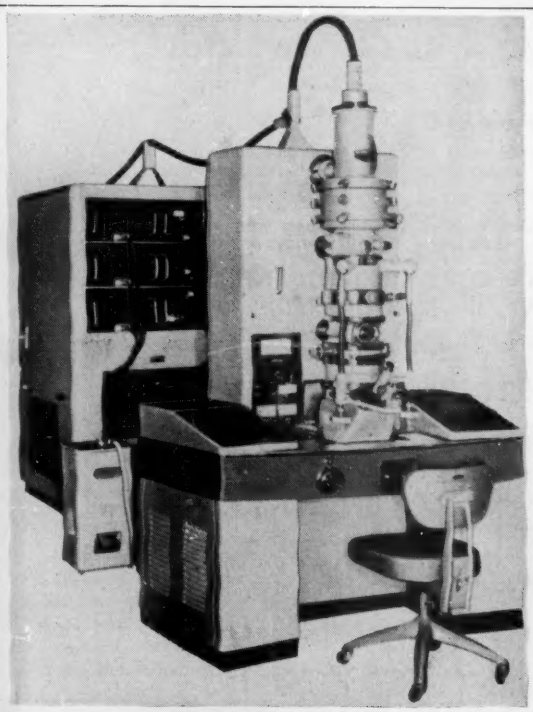
Speed, versatility, and convenience in measuring optical rotation, eliminating strenuous peering through an eyepiece with dark-adapted eyes.

*Write For Bulletin #330 to:*

**PHOTOVOLT CORP.**
95 Madison Avenue • New York 16, N. Y.

ALSO: pH Meters, Colorimeters, Fluorescence Meters, Densitometers.

---



New York Address:
**ERB & GRAY SCIENTIFIC, INC.**
**501 5th Ave., New York 17, N. Y.**

## *Announcing, the NEW*

# HITACHI HU - 11

# Electron Microscope

Erb & Gray Scientific, Inc., exclusive Hitachi distributor for the United States, is proud to present the all new Hitachi HU-11.

An amazing 5.63 Angstrom Units resolving power has been attained with the new instrument, which also provides a higher magnification range—up to 250,000 x—brighter illumination, and easier handling and servicing.

A resolving power of 8 to 10 Angstrom Units is guaranteed.

The new Hitachi HU-11, with a complete line of accessories available, provides a new high in performance for the electron microscopist.

*For further information, contact*

**ERB & GRAY SCIENTIFIC, Inc.**

*Exclusive Hitachi Distributors for the U. S.*

**854 S. Figueroa St., Los Angeles 17, Calif.**

# GET YOUR ADVANCE COPY

## of the General Program of the – AAAS Chicago Meeting

## by first class mail – early in December

The General Program of the 126th Meeting of the AAAS in Chicago, 26-31 Dec., 1959, will be available to you within the first week in December—whether you can attend the Meeting or not.

Effective this year, the former General Program-Directory, which had become an unwieldy book of more than 400 pages, has been separated into *two* publications, namely:

a) The Directory of AAAS Officers and Activities, 96 pp., already published; and
b) The General Program of the Annual Meeting, c. 200 pp., which will appear early in December

Both of these, sold at cost, may be purchased separately—in advance (see coupon below), or at the meeting. Some of their *respective* contents are:

**The General Program**

1. The two-session general symposium "Moving Frontiers of Science IV," arranged by the Committee on AAAS Meetings.
2. Programs of the 18 AAAS sections (symposia and contributed papers).
3. Programs of the more than 80 participating societies.
4. Sessions of the Conference on Scientific Communication, Conference on Scientific Manpower, and the Academy Conference.
5. The Special Sessions: AAAS Address and Reception, National Geographic Society, Phi Beta Kappa, Sigma Xi, RESA, Tau Beta Pi Association.
6. Details of the Morrison Hotel—center of the Meeting—and of the other session sites.
7. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
8. Exhibitors in the 1959 Annual Exposition of Science and Industry and descriptions of their exhibits.

**The Directory**

1. AAAS officers, staff, committees, for 1959.
2. Section committees and other AAAS Council members.
3. The 285 affiliated organizations.
4. Historical sketch and organization of the Association.
5. Complete roll of AAAS presidents and their fields.
6. Publications of the Association, including all symposium volumes.
7. AAAS Awards—including all past winners.
8. Future Meetings of the AAAS through 1963.
9. New and current activities of the AAAS.
10. Constitution and Bylaws.

### Advance Registration

Advance registration has these decided advantages: 1) You avoid delay at the Registration Center upon arrival; 2) You receive the General Program in ample time to decide, unhurriedly, which events and sessions you particularly wish to attend; 3) Your name is posted in the Visible Directory as the Meeting opens.

**The following coupon may be used both by advance registrants and by those who wish only the advance copy of the General Program; the Directory may also be ordered.**

### —THIS IS YOUR COUPON FOR AN ADVANCE COPY OF THE GENERAL PROGRAM— (AND FOR THE DIRECTORY, IF ALSO DESIRED)

1a. ☐ Enclosed is $3.00 for my advance Registration Fee which brings me the General Program, Convention Badge, and all privileges of the Meeting.

1b. ☐ Enclosed is $2.00 for only the General Program. (It is understood that, if I should attend the Meeting later, the Badge—necessary for the privileges of the Meeting—will be secured for $1.00 more.)

(Check 1a or 1b)

1c. ☐ Enclosed is $1.00 for the Directory of AAAS Officers and Activities to be sent now.

Total amount enclosed $.....

2. FULL NAME (Dr., Miss, etc.) .....
(Please print or typewrite) (Last) (First) (Initial)

ACADEMIC, PROFESSIONAL, OR BUSINESS CONNECTION .....

4. OFFICE OR HOME ADDRESS .....
(For receipt of General Program and/or Directory)

5. FIELD OF INTEREST .....

6. CONVENTION ADDRESS .....
(May be added later, after arrival)

Please mail this Coupon and your check or money order for the total amount to the
*AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE*
1515 Massachusetts Avenue, NW, Washington 5, D.C.

(Keio University) work on the isolated surviving frog heart, hypnotic and lethal actions of barbiturate, and changes of oxygen consumption of rat brain tissue homogenate; Harashima's (Keio University) observations on the urinary excretion of glucuronic acid in rabbits experimentally exposed to benzene and carbon disulfide; Ito's study on the detoxication of 2,4-dinitrophenol, and Takatsu's (University of Tokyo) work on the effect of sodium glucuronate on the $LD_{50}$ of *Shigella* endotoxin, phenol, pyramine, and noradrenaline in the young mouse.

In the field of virology, Ogasawara *et al.* (Nagoya University) studied the effects of glucuronic acid salts on the activity of influenza virus PR8 and of Newcastle disease virus in producing pyrogenic skin lesions and pulmonary consolidation. On the whole, infectivity, hemagglutinin, and antigenicity of these two viruses were not affected significantly, but the toxicity (skin lesion, pulmonary consolidation) was prevented by preliminary treatment with glucuronolactone. Coto *et al.* (University of Tokyo) observed the in vitro inhibition by glucuronic acid of mouse hepatitis virus, rabies virus, and Japanese encephalitis virus, with regard to their ability to infect the host mice.

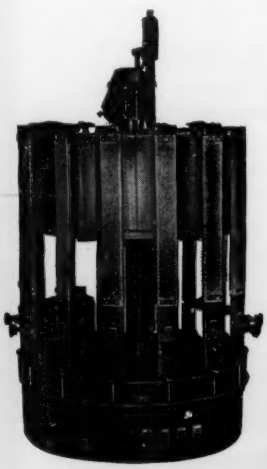
Clinical studies included work on the effects of glucuronic acid on steroid hormone excretion during pregnancy (Moriyama *et al.*); studies on glucuronic acid metabolism of newborn infants (Iwanami *et al.*); three separate investigations on glucuronic acid interrelationships with adrenal cortical function (Tokita *et al.*, Oshima *et al.*, and Kawai *et al.*); two reports on a therapeutic effect of glucuronolactone in diabetes mellitus (Katsuki *et al.* and Matsuoka *et al.*); the treatment of epidemic hepatitis with glucuronic acid (Kosaka *et al.*); and the influence of glucuronolactone on experimental liver injury induced by *Penicillium islandicum* Sopp poisons (Suzuki *et al.* and Uraguchi *et al.*).

It appears that with glucuronolactone occupying a central position in the glucuronic acid pathway of glucose metabolism, the basis of interpretation of the results of experimental and clinical work with exogenous glucuronolactone is to be found mainly in the field of carbohydrate metabolism. Nevertheless, "detoxifying" effects of glucuronolactone or glucuronic acid may be explained on a direct basis, such as in N-glucuronide formation, or may result indirectly from alterations in the dynamics of the glucuronic acid pathway. The evidence indicates that glucuronolactone is indeed a physiological nutrient or metabolite and its study provides many indications of rewarding further critical investigation.

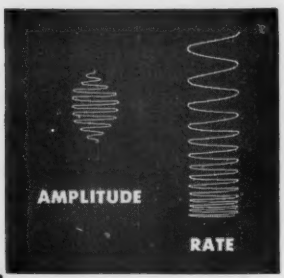
The address by W. H. Fishman (Tufts University School of Medicine) was published in monograph form (*Biochemistry of Glucuronic Acid Lectures in Japan*, published by the Glucuronic Acid Research Conference, University of Tokyo, 1959). Worthy of mention was the report of the discovery of a new 3-ketoheptose phosphate by Sie, Nigam, and Fishman, and the presentation of a concept of the role of β-glucuronidase in which the enzyme is believed to be associated with processes of cell and tissue differentiation rather than with cell division or growth per se.

I recall with great pleasure both the many enjoyable events of the conference and the lectures which it was my privilege to deliver at a number of Japanese institutions of higher learning. The kind and sincere hospitality of my hosts are herewith acknowledged with many thanks. My appreciation is expressed also to the National Science Foundation for granting a travel award.

WILLIAM H. FISHMAN
*Tufts University School of Medicine and New England Center Hospital, Boston, Massachusetts*



the Ultra-Compact 20-inch GME-LARDY WARBURG continuously variable

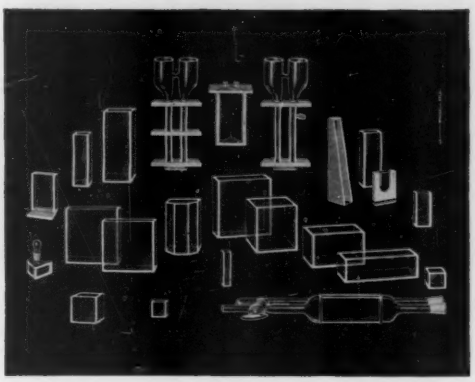



Model WB-4
Ultra-compact—smallest available. Only 20" base diameter. Integral construction—14 manometers. Amplitude and rate continuously variable. Write for complete information.

GME

MIDDLETON, WIS.
On Madison's West Beltline Highway

GLASS ABSORPTION CELLS made by KLETT

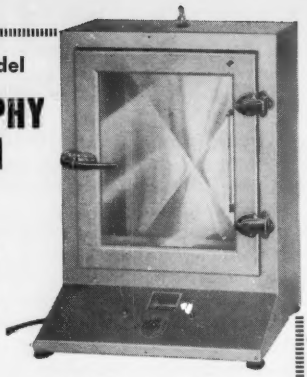


SCIENTIFIC APPARATUS
Klett-Summerson Photoelectric Colorimeters—Colorimeters — Nephelometers — Fluorimeters—Bio-Colorimeters — Comparators — Glass Standards—Klett Reagents.

Klett Manufacturing Co.
179 East 87 Street, New York, New York

Full View, Table Model

## CHROMATOGRAPHY DRYING OVEN



For Fast, Uniform Drying of Paper Chromatograms

Accurate development of four 18¼" x 22½" sheets simultaneously

Model CO-4 is a thermostatically controlled, insulated oven which quickly reaches temperatures up to 110° C. Achieves evacuation of solvent vapors with water or motor aspirator. Heating elements concealed in base are protected from combustible, solvent droplets. Heavy, metal-reinforced, safety glass door readily permits observation of color development without repeated opening of door. Stainless steel oven chamber is corrosion-resistant.

**Overall Dimensions: 27" wide; 37" high; 15½" deep**

**UNCONDITIONAL 1 YEAR WARRANTY**

*Write for Catalog CD-D11S*

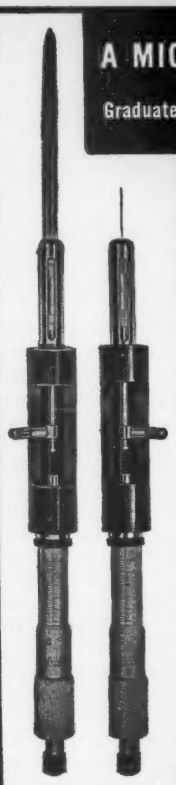
**NEW BRUNSWICK SCIENTIFIC CO., INC.**

PRECISION LABORATORY APPARATUS

P.O. BOX 606, NEW BRUNSWICK, NEW JERSEY

## A MICRO SYRINGE/BURETTE

Graduated In Units Of 0.0001 ml.



Volume of liquid delivered is precisely measured with a micrometer—down to 0.0001 ml.

Total capacity 0.25 ml.

Volume setting can be maintained for repeated deliveries of identical volumes.

Quickly converted from micro-syringe to micro-burette.

Teflon, glass, and stainless steel construction.

*Write for Brochure SM*

**CALIFORNIA LABORATORY EQUIPMENT CO.**

98 Rincon Road • Berkeley 7, California

## NOW! *a low cost Michelson* INTERFEROMETER

This precision instrument is ingeniously designed to provide .2% accuracy at minimum cost. Directly calibrated in inches. Clear, well defined fringes are observable and measurable. Refractive properties of transparent materials can be easily studied. Sturdily constructed for classroom or laboratory research.

**Complete with monochromatic mercury light and illustrated experiment manual . . . only $209.95**

cenco®

**CENTRAL SCIENTIFIC CO.**

*A Subsidiary of Cenco Instruments Corporation*

**1718M Irving Park Road • Chicago 12, Ill.**

**Branches and Warehouses**—Mountainside, N. J. Boston • Birmingham • Santa Clara • Los Angeles • Tulsa Houston • Toronto • Montreal • Vancouver • Ottawa

## ZOOGEOGRAPHY

**Editor CARL L. HUBBS**

**To the Memory of Charles Darwin and Alfred Russel Wallace**

**AAAS Symposium Volume No. 51**
**510+x pp., 115 illus., 13 tables, 6x9, author index of scientific names, references, cloth**

**AAAS members' cash orders $10.50, Retail $12.00**

August 1957 Stanford Symposium:
The Origins and Affinities of the Land and Freshwater Fauna of Western North America

December 1957 Indianapolis Symposium:
Some Unsolved Problems in Biology, 1957:
Geographic Distribution of Contemporary Organisms

. . . a vast storehouse of information,

. . . a kinetic approach, concerned with processes and explanations

. . . great diversity in: groups of organisms—areas covered—topics stressed—angle of approach

English Agents: Bailey Bros. & Swinfen, Ltd.
Hyde House, West Central Street, London W.C.1

**American Association for the Advancement of Science**

**1515 Massachusetts Avenue, NW, Washington 5, D.C.**

## Forthcoming Events

### January

*6–8.* Northeastern Weed Control Conf., 14th annual, New York, N.Y. (M. G. Wiltse, Chairman, Public Relations Committee, Dow Chemical Co., 916 Shoreham Bldg., 15 and H Sts., NW, Washington 5, D.C.)

*7–10.* Radioactive Isotopes, 4th intern. symp., Bad Gastein, Austria. (R. Hofer, Isotopen-Laboratorium, II. Medizinische Universitäts Klinik, 13, Garnisongasse, Vienna 9, Austria.)

*8–11.* Sanitary Engineering Conf., ASCE, Cincinnati, Ohio. (E. S. Kirkpatrick, ASCE, 33 W. 39 St., New York 18.)

*11–13.* American Acad. of Allergy, Hollywood-by-the-Sea, Fla. (J. O. Kelley, 756 N. Milwaukee St., Milwaukee 2, Wisc.)

*11–13.* Arctic Geology, 1st intern. symp. Calgary, Alberta, Canada. (D. W. R. Wilson, Arctic Symposium Committee, P.O. Box 100, Calgary, Alberta, Canada.)

*11–13.* Reliability and Quality Control, natl. symp., Washington, D.C. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

*11–15.* Society of Automotive Engineers, annual, Detroit, Mich. (R. W. Crory, Meetings Operation Dept., SAE, 485 Lexington Ave., New York 17.)

*11–25.* Effects of Atomic Radiation, New York, N.Y. (R. Appleyard, Scientific Committee on the Effects of Radiation, United Nations, New York 17.)

*12–15.* Society of Plastics Engineers, 16th annual conf., Chicago, Ill. (T. A. Bissell, SPE, 65 Prospect St., Stamford, Conn.)

*14–18.* American Inst. of Mining, Metallurgical, and Petroleum Engineers, annual, New York, N.Y. (E. O. Kirkendall, AIMMPE, 29 W. 39 St., New York 18.)

*17–30.* Bahamas Medical Serendipity Conf., 2nd, Nassau. (B. L. Frank, P.O. Box 4037, Fort Lauderdale, Fla.)

*18–21.* American Astronautical Soc., 6th annual, New York, N.Y. (A. P. Mayernik, AAS, 6708 53 Rd., Maspeth 78, N.Y.)

*19–21.* American Meteorological Soc., 40th annual, Boston, Mass. (K. C. Spengler, 3 Joy St., Boston.)

*19–21.* Congenital Malformations, CIBA symp. (by invitation only), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

*21–23.* American College of Surgeons, Louisville, Ky. (H. P. Saunders, 40 E. Erie St., Chicago 11, Ill.)

*23–28.* American Acad. of Orthopedic Surgeons, Chicago, Ill. (J. K. Hart, 116 S. Michigan, Chicago 3.)

*24–29.* American Rocket Soc., Princeton, N.J. (J. J. Harford, ARS, 500 Fifth Ave., New York 36.)

*25–28.* Institute of the Aeronautical Sciences, 28th annual, New York, N.Y. (IAS, 2 E. 64 St., New York 21.)

*25–28.* Plant Maintenance and Engineering Show, Philadelphia, Pa. (R. S. Wolcott, Clapp & Poliak, 341 Madison Ave., New York 17.)

*25-29.* Stress Measurement Methods, symp., Tempe, Ariz. (P. K. Stein, Strain Gage Readings, 5602 East Monte Rosa, Phoenix, Ariz.)

*(See issue of 13 November for comprehensive list)*

# New Products

*The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither* Science *nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.*

■ MAGNETIC-TAPE CONVERTER makes possible direct use of digital magnetic tape as input to automatic graphical plotters. Solid-state switching circuitry is used with patchboard programing. Provision is included for omitting records that contain specified characters. (Benson-Lehner Corp., Dept. Sci254, 11930 West Olympic Blvd., Los Angeles 64, Calif.)

■ RATIO STANDARD combines a d-c divider and a ratio transformer. Model 1001 handles a-c input voltages of 0.35 times the frequency from 50 to 10,000 cy/sec. Model 1002 handles inputs of 2.5 times frequency from 30 to 1000 cy/sec. Input resistance of the d-c section is 10,000 ohms, and power rating is 5 watts. Linearity is said to be 0.0001 percent for a-c and 0.001 percent for d-c. (Gertsch Products, Inc., Dept. Sci-255, 3211 South La Cienezo Blvd., Los Angeles 16, Calif.)

■ FREQUENCY CALIBRATOR furnishes standard frequencies from 10 kcy/sec to 1000 Mcy/sec with short time stability of $1/10^7$. The instrument also provides timing markers at decade intervals from 0.1 to 100 μsec. An internal crystal oscillator is coupled to a 2-to-1 multiplier followed by a 10 Mcy/sec buffer that drives a series of multivibrators with fundamentals of 1 Mcy/sec and 100 and 10 kcy/sec. (General Radio Co., Dept. Sci259, West Concord, Mass.)

■ RESISTORS of radial-lead and axial-lead encapsulated types are said to be available with absolute accuracies from ±0.005 to ±0.1 percent and stability ±0.003 percent per year. Accuracy over the temperature range −30° to +85°C is said to be ±0.02 percent, and matched sets which track within ±0.005 percent from −45° to +85° can be provided. Resistances from 1 ohm to 4 megahom are available. (Julie Research Laboratories, Dept. Sci260, 556 W. 168 St., New York 32, N.Y.)

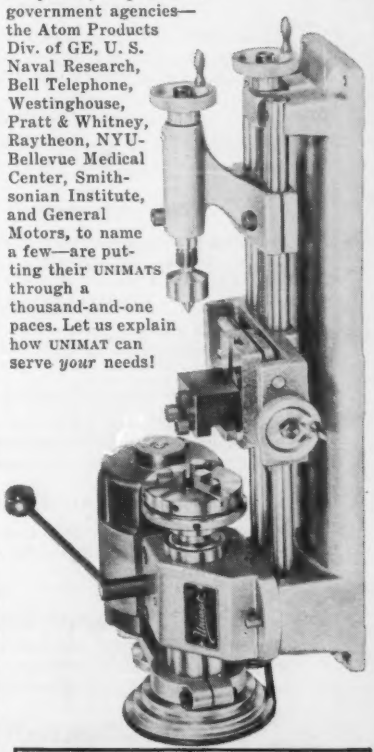
■ AIR MONITORING SYSTEM is said to eliminate interference of natural radon with measurement of long-half-life emitters by measuring the ratio of beta-gamma to alpha activity. Change in this ratio, essentially constant in natural radron-thoron progeny, indicates presence of other than normal background. Ratio rise indicates long-half-life predominantly beta activity; ratio fall, pre-

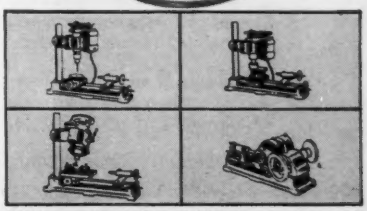

EVEN WHEN STANDING ON ITS HEAD STOCK

**UNIMAT**

IS A PRODUCT DESIGNER'S BEST FRIEND!

**MULTI-FUNCTION MACHINE SHOP-IN-MINIATURE** (just 16" long) is indispensable to the modern research lab or model shop. *Designers* and *engineers* supplement their sketches with machined-to-scale models anybody can "read." *Technicians* turn out parts with micrometrically fine tolerances—down to .0005". *Manufacturers* developing new products save space and money in the mock-up shop by taking advantage of UNIMAT'S amazing convertability. Hundreds of blue-chip companies, hospitals and government agencies—the Atom Products Div. of GE, U. S. Naval Research, Bell Telephone, Westinghouse, Pratt & Whitney, Raytheon, NYU-Bellevue Medical Center, Smithsonian Institute, and General Motors, to name a few—are putting their UNIMATS through a thousand-and-one paces. Let us explain how UNIMAT can serve *your* needs!





**THIS IS THE BASIC UNIMAT,** *complete with lathe, motor, and all components for converting to drill press, vertical milling machine, tool and surface grinding machine, and polisher/grinder. Low cost attachments—jig saw, threader, circular saw, indexer/divider —are available, along with a complete range of machine accessories.*

*Write for illustrated literature and price list.*

**AMERICAN-EDELSTAAL/UNIMAT DIVISION**
350 Broadway, New York 13, N.Y. Dept. AK

# *Research Scientists*

## FOR BASIC & APPLIED RESEARCH AT

# *Sylvania's Research Laboratories*

Significant expansion of company-supported research in solid state physics, physical electronics, metallurgy and physical chemistry has created a number of exceptional opportunities at several levels, up to Senior Scientist or Section Head. Inquiries are invited from persons with appropriate training and experience who would be interested in participating in one of the following programs:

**REFRACTORY METALLURGY**

Theoretical and experimental investigations of all phases of the metallurgy of refractory metals and alloys including process, fabrication, physical and mechanical metallurgy.

**ELECTRONIC MATERIALS**

Synthesis and evaluation of materials and studies of the basic mechanisms involved in magnetics, ferrites, phosphors and dielectrics.

**ELECTRONIC COMPONENTS**

Investigations of techniques and materials involved in microminiaturization and integrated circuits.

**ANALYTICAL CHEMISTRY**

Analysis of ultra-trace impurities in electronic materials, semiconductors and metals including the development of new analytical techniques.

**THERMIONIC EMISSION**

Studies of the basic mechanisms of electron emission from high and low temperature surfaces; experimental evaluation of emission properties of base alloys, films and matrix forms.

**MICROWAVE & ULTRA-MICROWAVE ELECTRONICS**

Theoretical and experimental investigations of Maser-like devices and parametric amplifiers, including microwave spectroscopy studies of paramagnetic crystals.

**SEMICONDUCTOR DEVICES**

Theoretical and experimental studies of new devices and device concepts, new fabrication techniques and the applications of new semiconductor materials and phenomena.

**SEMICONDUCTOR MATERIALS & POLAR CRYSTALS**

Studies of the basic phenomena and properties of existing and new materials with these characteristics.

*Modern, fully equipped laboratories, considerable scientific freedom, and association with staff members of established scientific prestige afford realistic opportunities for professional growth and recognition.*

*Please submit resume in confidence to Mr. A. E. Powell, Dept. S-12*

**RESEARCH LABORATORIES**

**SYLVANIA** GENERAL SYSTEM

Subsidiary of

**GENERAL TELEPHONE & ELECTRONICS**

Bayside, Long Island, New York


dominantly alpha activity. The system records alpha activity, beta-plus-gamma activity, and ratio of beta-gamma to alpha. (Nuclear Measurements Corp., Dept. Sci263, 2460 N. Arlington Ave., Indianapolis 18, Ind.)

■ FUEL-GAGE TESTER contains a pair of three-terminal air capacitors, one to simulate the jet fuel compensator, the other, in conjunction with fixed capacitors, to simulate the main sensing capacitor of a fuel gage. Capacitor scale length is 19.2 ft, and settings are accurate to 1 in 25,000. Capacitors are enclosed, with a removable desiccant cartridge. (General Radio Co., Dept. Sci262, West Concord, Mass.)

■ TUBE-TRANSISTOR BRIDGE with amplification factor range of 0.001 to 10,000 can be used to measure low-frequency dynamic coefficients of transistors and tubes over wide ranges of values. The bridge is designed to operate in the 270 to 400 or 1000 cy/sec range. Vacuum-tube measurements can be made on forward and reverse amplification factor, resistance, and transconductance. In transistor applications the bridge can be used to determine short-circuit conductance parameters and the forward- and reverse-voltage ratios. Dynamic-plate-resistance range is 50 ohm to 20 megohm. Transconductance range is 0.02 to 50,000 μmho. Maximum plate current is 400 ma; maximum voltage is 1500 v. (General Radio Co., Dept. Sci265, West Concord, Mass.)

■ IONIZATION DETECTOR for gas and vapor chromatography is nonradioactive. Electrons for ionization are supplied by emission, and ionizing energy is controllable. The detector is suitable for use with either capillary or packed columns. Helium and argon are the preferred carrier gases. Small changes in temperature or pressure are said to have no adverse effect on operation. Flow is held constant during an analysis. (Burrel Corp., Dept. Sci268, 2223 5th Ave., Pittsburgh 19, Pa.)

■ SYNCHRONOUS MOTOR runs at 72 rev/min without gear reduction with 60 cy/sec input. Clockwise or counterclockwise rotation with rapid reversing is possible. Start or stop time is less than 0.025 second, or 5 deg of shaft rotation. Torque is 150 oz/in. Starting current and running current are nearly identical. The motor may also be used as a d-c stepping motor for incremental positioning with either 200 or 400 increments for one shaft rotation. Rated torque is maintained for all stepping positions. (Superior Electric Co., Dept. Sci270, 83 Laurel St., Bristol, Conn.)


JOSHUA STERN

*National Bureau of Standards, Washington, D.C.*

# PERSONNEL PLACEMENT

**CLASSIFIED: Positions Wanted, 25¢ per word, minimum charge $4. Use of Box Number counts as 10 additional words. Payment in advance is required. Positions Open, $33 per inch or fraction thereof. No charge for box number.**

**COPY for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).**

**DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.**

| | |
|---|---|
| **Single insertion** | **$33.00 per inch** |
| **4 times in 1 year** | **30.00 per inch** |
| **7 times in 1 year** | **28.00 per inch** |
| **13 times in 1 year** | **27.00 per inch** |
| **26 times in 1 year** | **26.00 per inch** |
| **52 times in 1 year** | **25.00 per inch** |

**For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).**

**Replies to blind ads should be addressed as follows:**
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

## POSITIONS WANTED

**Biochemist,** Ph.D. Findings on purines, nucleotides, exopeptidases. Desires position investigating deoxyribonucleotides. Five years of institute experience. Minors: organic chemistry and microbiology. Box 232, SCIENCE. X

**Clinical Research Director-Pharmaceuticals.** Proven ability. Please write c/o RESCON, 30 W. Washington, Chicago 2, Illinois. 12/25

**Microbiologist-Biochemist,** Ph.D.; 31; industrial academic experience; wide background in general microbiology, antibiotics, microbial biochemistry, chemotherapy. Box. 258, SCIENCE. X

(a) **Microbiology Ph.D.** with biological chemistry minor; 3 years' experience as plant pathologist in fermentation research; prefers commercial research appointments. (b) **Entomologist,** M.S. degree, Ph.D. in 1960; desires teaching or research position in zoology-parasitology or preventive medicine; S12-2 Medical Bureau, Inc., Burneice Larson, President, 900 North Michigan Avenue, Chicago. X

**Microbiologist,** Sc.D., Massachusetts Institute of Technology. Interested in applied microbiology, biochemical engineering, fermentations. Seeks academic position. Publications. Presently U.S. Public Health Service postdoctoral fellow abroad. Box 263, SCIENCE. X

**Organic Chemist;** 36, family; Ph.D., 1954. Teaching since 1947. Active in cancer chemotherapy since 1956. Publications. Available February 1960. Box 259, SCIENCE. X

**Pharmacologist, Toxicologist,** Ph.D. Industrial, government, academic, and research background since 1945. Box 264, SCIENCE. X

**Virologist,** Ph.D. Interested viral tumor program, infectious nucleic acids, transformation. Experienced tissue culture, virology, phage transduction. Box 261, SCIENCE. X

## POSITIONS OPEN

(a) **Bacteriologist;** supervise bacteriology, parasitology in very large university-affiliated general hospital; active research program, southcentral university city. (b) **Biochemist,** M.S. preferred, to head department fully approved 400-bed general hospital; minimum $6800; midwestern college town. (c) **Bacteriologist;** active department, excellent working conditions; 500-bed general hospital; mideastern college city 250,000. (d) **Biochemist;** prefer some bacteriology, serology experience; new 100-bed general hospital; to $10,-800; southern California. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

**Biologist,** recent bachelor's degree for cytochemical studies. Send complete vitae, Box 260, SCIENCE. X

**Biologists.** New southern California state college is seeking botanists and zoologists. Prefer geneticist, physiologist, embryologist, endocrinologist. Specialty is less important than excellence in biology. Applicant should be interested in teaching lower division biology courses as well as courses in his specialty. Please send full résumé. Box 246, SCIENCE. 12/18

## POSITIONS OPEN

**Invitation to EMPLOYERS & EMPLOYEES!**

National Scientific Personnel Bureau, Inc. ME 8-2567

We cordially invite you to visit our Booth No. 42, 26–31 December, at the 1959 Exposition of Science and Industry, AAAS Meeting, Chicago, Illinois. *Employers are invited to submit positions specifications; employees, invited to register, now.*

Confidential handling. Salaries $6000–$60,000. Personalized service. Write Dr. A. H. Hammond, Chairman, Liaison Committee, Box 2707, Washington 13, D.C.

## BIOLOGICAL SCIENTIST Ph.D.

THE MAN—High academic qualifications; imagination; facility in communication, written and oral, with both scientists and non-scientists.

THE JOB—Significant role in clinical development of new therapeutic agents including design of studies, interpretation of data, and evaluation of clinical utility. Wide contact with company scientists, clinicians and management. Ample opportunity to attend important conferences and to contact investigators.

Send reply to:

L. H. WATSON
SMITH KLINE & FRENCH LABORATORIES
1520 Spring Garden St.
Philadelphia 1, Pa.

*ENDOCRINOLOGIST,* M.D. or Ph.D. to organize research group. Experience in physiological aspects of endocrinology and background in steroids required. Excellent working conditions. Address confidential inquiries to Employment Division, Abbott Laboratories, North Chicago, Illinois.

**Graduate Assistantships in Biochemistry.** Teaching and research assistantships leading to Ph.D. available for academic year 1960-1961. Modern air-conditioned building with excellent facilities. Wide variety of research projects available. Initial stipend, $2670 plus tuition to a total of $3196 for 12 months' service. Write Dr. R. E. Olson, Chairman, Department of Biochemistry and Nutrition, Graduate School of Public Health, University of Pittsburgh, Pittsburgh 13, Pennsylvania. 12/11

(a) **Head Biochemist** with Ph.D. for important university hospital, South. (b) **Mycologist or Ph.D.** in allied field for enzyme-fermentation research with leading pharmaceutical laboratories, East. (c) **Research Biochemist** for long-term project on shock in surgery department of leading teaching hospital, Midwest. (d) **Virologist** with Ph.D. or M.D. degree for research on clinical virology, epidemiology of infectious diseases, and so forth, for large chemical firm, Midwest. (e) **Head of Chemistry Department** of liberal arts college, M.A. or Ph.D. degrees, California. (f) **Literature Scientist** with knowledge of German for expanding science information center of important pharmaceutical firm, Midwest. S12-2 Medical Bureau, Inc., Burneice Larson, President, 900 North Michigan Avenue, Chicago. X

**New World-Wide Graduate Award Directories** for American scientists, teachers, librarians to subsidize their education and research. Stipends $200–$10,000. Volume I (1957), $3; volume II (just published, no duplication), $3; both volumes, $5. Limited editions. Complete, specific information on 400 awards in United States and overseas in each volume. CRUSADE, Sci., Box 99, Station G, Brooklyn 22, N.Y. eow

# Investigate the widest variety of openings in recent years

### *At the Knolls Atomic Power Laboratory*

For the first time in recent years, current openings here extend into disciplines generally considered outside of the traditional nuclear areas. As a result, excellent opportunities exist today for men interested in entering the nuclear field for the first time, as well as for recent graduates and, of course, experienced nuclear engineers and scientists. If you've been thinking of exploring professional opportunities at KAPL, we suggest you make your initial inquiry today.

**Current Openings:**

**Reactor structural design**
**Primary & secondary systems design**
**Reactor operation**
**Heat transfer, fluid flow**
**Shielding design**
**Powerplant performance evaluation**
**Powerplant & reactor instrumentation**
**Powerplant & reactor controls**
**Control drive design**
**Electronic equipment development**
**Experimental reactor physics**
**Theoretical reactor physics**
**Nuclear analysis**
**Mass spectrometry**
**Reactor materials development**
**Process development metallurgy**
**Materials irradiations experiments**
**Materials quality control**
**Mechanical metallurgy**
**Metallography**
**Applied ceramics**
**Chemical analysis, vacuum techniques**
**Analytical chemistry, X-ray diffraction**
**Radiochemistry**
**Corrosion technology**
**Advanced engineering mathematics (PhD)**
**Advanced numerical analysis (PhD)**
**Mathematical statistics & design of experiments (PhD)**
**Mathematical analysis & computer programming**
**Computer operations**

*U.S. Citizenship Required*

Forward your resume in confidence, including salary requirement. Please also state your job interests. Address: Mr. A. J. Scipione, Dept. 74-WW

Knolls Atomic Power Laboratory
operated for the A.E.C. by
GENERAL ELECTRIC
Schenectady, N.Y.

## POSITIONS OPEN

### BIOCHEMISTS
### Research

Challenging positions exist in the field of food chemistry and food technology for men with M.S. and Ph.D. degrees and research experience in this field. These positions offer an opportunity to use your initiative and creative ability on programs in proteins and carbohydrates.

Excellent employee benefits, including tuition-free graduate study and liberal vacation policy. Please send complete résumé to:

**E. P. Bloch**
**ARMOUR RESEARCH FOUNDATION**
**of**
**Illinois Institute of Technology**
**10 West 35th Street**
**Chicago 16, Illinois**

---

**IMMUNOLOGIST** with background in endocrine physiology, or **Endocrine Physiologist** with immunology experience, M.S., or Ph.D., for metabolic research program of 727 GM&S bed Veterans Administration Hospital affiliated with Indiana University School of Medicine. Study of endocrine alterations in growth and ageing, and endocrine disease. Salary depending on experience and education. Career Civil Service. Write Personnel Officer, Veterans Administration Hospital, 1481 W. 10th Street, Indianapolis 7, Indiana. 12/18

---

**Male or Female,** M.S. or Ph.D., research laboratory, electron microscopy of tissues and animal tissue cultures. Background in cytology or related field and experienced in operation of electron microscope. Send detailed résumé to Dr. Christensen, Saint Barnabas Medical Center, High St., Newark, N.J. 12/18

---

**Postdoctoral Traineeships in Enzyme Chemistry** are available for 1960–61 at the University of Wisconsin, Institute for Enzyme Research, in Madison. Applications may be submitted at any time and are invited from candidates who have completed or will shortly complete the requirements for either the Ph.D. or M.D. degree and who are U.S. citizens. The period of traineeship is 12 months (including 1 month's vacation) and may be renewed for additional years. Stipends are $6000 per year and, in most cases, partially tax exempt. A travel allowance is provided the trainee from his present institution (if within continental United States) to Madison. Senior traineeships are available to persons who by virtue of previous postdoctoral training and/or experience have demonstrated outstanding ability. Application forms and information may be obtained by writing to Dr. David E. Green, Program Director. 12/4

---

**Research Associate.** For research in physical and dento-facial growth of children. An orthodontist or dentist with graduate training or a zoologist, physical anthropologist, or geneticist with Ph.D. Excellent research facilities. Salary and academic rank dependent on training and experience. Applications with full particulars and references to Dr. Shim S. Savara, Head of Department, Child Study Clinic, University of Oregon Dental School, 611 S.W. Campus Drive, Portland 1, Oregon. 12/4

---

**ORGANIC CHEMIST OR BIOCHEMIST**

Unusual opportunity in growing medium-size laboratory, Chicago area. Manufacturer of additives for foods, pharmaceuticals, and feeds. Industrial experience required in allied field. Excellent growth benefits. Please submit detailed résumé. Replies confidential.

**Box 265, SCIENCE**

---

**Research Technicians** with B.S. degree in biology, chemistry, or biochemistry, for interesting work in the medical research field. Perquisites include 3 weeks vacation, 9 holidays, sick leave, retirement plan, social security, hospitalization and life insurance programs. For additional information please submit résumé to Personnel Manager, The M. D. Anderson Hospital and Tumor Institute, Texas Medical Center, Houston, Texas. 12/18, 25; 1/1

## POSITIONS OPEN

### SCIENTIFIC DIRECTOR

Medium sized ethical pharmaceutical manufacturer, in Metropolitan New York area, expanding its research program, offers exceptional opportunity for creative individual with strong record of research and new product development. This is a high level post with substantial remuneration to the right man.

Send complete résumé in confidence to

**Box 271, SCIENCE**

---

**THE UNIVERSITY OF ALBERTA** invites applicants for positions in the **Department of Mathematics** at the **Lecturer, Assistant Professor and Associate Professor** levels. Salaries for 1960–61 will be in the ranges $6000 to $8200 for assistant professor, $8500 to $10,500 for associate professor. Commencing salaries will depend upon experience and qualifications, and regular annual increments are normally given. Appointments will date from 1 September 1960. A pension plan is in operation, and a removal grant may be made for married appointees and for single persons coming from outside North America. Applications, accompanied by curriculum vitae, transcripts, recent snapshot, and names of at least two responsible referees, should be forwarded to Professor E. S. Keeping, Mathematics Department, University of Alberta, Edmonton, Canada. 12/18

## FELLOWSHIPS

**Research Fellowships, Teaching Assistantships, and Tuition Scholarships** available for graduate students. Concurrent awards up to $2500 per year, in addition to tuition. Active graduate research in mechanisms of organic reactions, chemistry of free radicals, stereochemistry, chemotherapy, mechanism of enzyme reactions, organo-phosphorus compounds, natural products, kinetics of elementary reactions, theories of atomic and molecular structure, photochemistry, photosynthesis, solid-state chemistry, and electron paramagnetic resonance. Direct inquiries to Chairman, Department of Chemistry, Brandeis University, Waltham 54, Massachusetts. 12/4

# The Market Place

**BOOKS • SERVICES • SUPPLIES • EQUIPMENT**

**DISPLAY:** Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

| | |
|---|---|
| Single insertion | $33.00 per inch |
| 4 times in 1 year | 30.00 per inch |
| 7 times in 1 year | 28.00 per inch |
| 13 times in 1 year | 27.00 per inch |
| 26 times in 1 year | 26.00 per inch |
| 52 times in 1 year | 25.00 per inch |

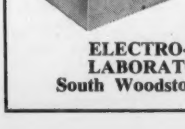
**For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).**

## SUPPLIES AND EQUIPMENT

- **HYPOPHYSECTOMIZED RATS**

Shipped to all points via Air Express
For further information write
**HORMONE ASSAY LABORATORIES, Inc.**
**8159 South Spaulding Ave., Chicago 29, Ill.**

---



**THE JUNIOR**
**Garceau**
**Electroencephalograph**
**Price $575.00 complete**
**No Batteries**
**Requires no Shielding**
**Prompt Delivery**
**A.C. Operated**
**Inkless Writing**
**Shipped Ready to Run**

**ELECTRO-MEDICAL LABORATORY, INC.**
**South Woodstock 2, Vermont**

## SUPPLIES AND EQUIPMENT

**YOU NEED THIS FREE CATALOG FOR YOUR FILES**

Serums, antiserums and bloods of all kinds for technicians and tissue culture laboratories. No salesman will call.

**COLORADO SERUM CO.**
4950 York St. • MAin 3-5373 • Denver 16, Colo.

---

*"From the hand of the veterinarian to research."*®

**albino rats**

CHARLES RIVER CD
(Caesarean derived)
CHARLES RIVER SD
(Sprague-Dawley descendants)
CHARLES RIVER W
(Wistar descendants)

**HYPOPHYSECTOMIZED RATS**

- Only Charles River CD animals used
- Rigidly controlled environment (same bldg.) birth to surgery.
- High speed surgery by graduate biologists.
- 10 years experience animal surgery.
- Overnight air service from Boston

**THE CHARLES RIVER BREEDING LABS**
Dept. B, 1093 Beacon Street, Brookline 46, Mass.
*Henry L. Foster, D.V.M., President*

---

**FREE** Subscription to AEROGRAPH Research Notes, a technical publication on new developments in gas chromatography. We offer a complete selection of essential supplies and the Aerograph line of GLPC equipment.

**Gas Chromatography**

*Send for your free subscription today*
**WILKENS INSTRUMENT & RESEARCH INC.**
Box 313, Walnut Creek, California
YEllowstone 5-1469

---

**1919-1959**
**LaMotte Chemical**
**Chestertown, Maryland, U.S.A.**
**Specialists in**
**Colorimetric Techniques**
**Reagents-Standards-Comparators**
***Send for Illustrated***
***Controls Handbook*** ***Dept. H***

## BOOKS AND MAGAZINES

**Your sets and files of scientific journals**

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, CANNER'S, Inc. Boston 20, Massachusetts

---

**MAMMARY TUMORS IN MICE**

**AAAS Publication No. 22.** By the staff of the National Cancer Institute, National Institutes of Health, U.S. Public Health Service.

Edited by FOREST RAY MOULTON
7⅛" x 11½", double column, cloth, references, 20 tables, 52 illus. Published 1945—Now offered at reduced price.

**$3.00 prepaid orders by AAAS Members, $3.50 retail**

**AAAS**
**1515 Massachusetts Avenue, NW, Washington 5, D.C.**

***RESEARCH SCIENTISTS and ENGINEERS with MS, PhD or ScD***

# The Academic Approach to Research

## *...can it be transplanted to an industrial laboratory?*

YES...in its environment of free inquiry and in scholarly consideration of the work of qualified colleagues.

This attainment is the experience of members of the Scientific Research Staff at Republic Aviation. Here, the initiation of original research is encouraged and generous support is provided to demonstrate the validity of theoretical concepts.

A preference exists for theoretical and experimental studies related to the many and varied disciplines of aeronautics and astronautics. These cover a wide spectrum of scientific research in its most active and interesting aspects.

At the same time, more emphasis is placed upon bringing new theories into the realm of feasible engineering than would normally be found at an academic institution.

### THE PRACTICAL RESULTS OF THIS POLICY

The fruitfulness of the research environment at Republic is evidenced by the advancements and developments continually resulting. One well-known example is the current research and development of the Plasma Pinch Engine (for interplanetary travel) conceived by members of the Scientific Research Staff. Other wide-ranging research programs concern such subjects as the theory of lifting fans, new sophisticated methods of structural analysis, advanced electronic systems and techniques, space mechanics and nuclear physics, among others.

### SCIENTISTS AND ENGINEERS ARE INVITED TO JOIN OUR STAFF AS NEW RESEARCH CENTER NEARS COMPLETION

Early in 1960, a new Research Center, including 7 modern laboratories, will be completed to support Republic's expanding effort in research and advanced development. Existing areas of investigation are being enhanced and new ones will be initiated.

If your interests coincide with the work of such a group and you feel you can contribute to progress in any of the physical and engineering sciences related to aeronautics and astronautics — Republic would like to talk with you. Salaries are high, commensurate with talent and expert knowledge.

### IMMEDIATE OPPORTUNITIES EXIST FOR SCIENTISTS WITH APPROPRIATE RESEARCH EXPERIENCE AND ADVANCED DEGREES IN:

- Navigation and Communication Systems
- Electronic Theory
- Electronic Circuits and Components
- Nuclear Physics
- Nuclear Power
- Nuclear Propulsion
- Aerodynamics and Fluid Mechanics
- Theory of Lifting Fans
- Applied Mechanics
- Space Environment
- Missions and Trajectories
- Space Flight Control
- Applied Mathematics
- Hypersonics
- Plasma Dynamics

*Write in confidence directly to:*
**Dr. Theodore Theodorsen**
**Director of Scientific Research**

**REPUBLIC AVIATION**
**Farmingdale, Long Island, New York**

# NUCLEAR REVIEWS

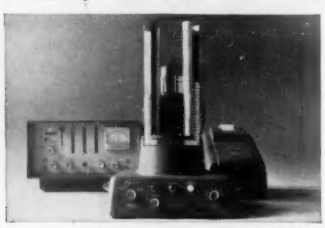
from

NUCLEAR-CHICAGO

## RADIATION AUTOMATION

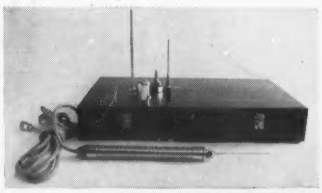
Many busy laboratories working with radioisotopes have found an ideal way to eliminate the time and cost consuming procedure of manually counting beta-emitting samples. They use Nuclear-Chicago's Automatic Sample Changer System, which must provide a notable procedural improvement because it has become the most widely used System of its kind in the world today.

Where a large number of samples must be counted this System drastically cuts the technician's time for routine radioassay work and makes it available for the more productive phases of research. Up to 35 samples may be counted without attention and, with the human element eliminated, more accurate and more reproducible results are obtained than with manual counting techniques. As pictured here the System consists of our C-110B Automatic Sample Counter, scaler and newly-improved printer-timer. Normally used with the D-47 Gas Flow Counter, windowless or with "Micromil"® window, the automatic changer will also operate efficiently with mica window or beta scintillation detectors. If you have a volume sample counting problem, may we suggest you write us for full information on this world's most popular automatic sample counter system.



## HYPERTHYROID RABBITS???

Biologists and clinical researchers faced with the problem of taking measurements of the radioactivity concentrated in the thyroid gland or in any organ in a small animal no longer need be frustrated because radiation detectors are often larger than the animal itself and "see" practically all the radiation in the animal.



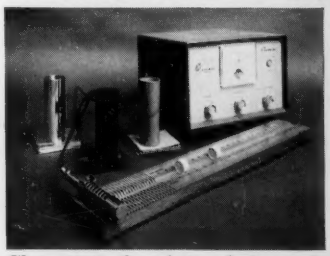
A new scintillation detector originally developed by Nuclear-Chicago for brain tumor localization has such tiny beta-gamma sensitive crystals that measurements of thyroid uptake of radioiodine-131 in a rabbit or mouse become easy. One of the interchangeable probe tips is even supplied with a collimator shield to increase directional sensitivity. If you're interested in detecting and measuring radioactivity in animals, humans, or anywhere where there's little room to work, you'll be interested in the new Nuclear-Chicago DS8-1 scintillation detector set. We'll be pleased to send full information.

## GRANTS TO SCHOOLS

Financial grants from AEC for equipment have been an important factor in setting up nuclear training programs in educational institutions. There is an interesting angle to this, however, that was recently brought to light. It seems that 98% of all AEC equipment grants have gone to institutions with more than 1,000 enrollment and less than 2% to the smaller schools. The reason is that qualifications for such grants are based on the ability of the requesting institution to put the proposed equipment to maximum good use.

No one questions the fact that students in all schools should have the opportunity to study nuclear techniques, but the smaller school, with its limited budgets, may lack the trained personnel required to meet AEC qualifications. Here at Nuclear-Chicago we have been conscious of this need and have spent a lot of effort in developing reliable low cost equipment which will enable the smaller school to acquire the necessary familiarity with nuclear techniques.

For instance, our basic nuclear demonstration unit The



Classmaster®, pictured here, is available for only $194.50. It includes a ratemeter, Geiger tube, absorption and scatter shields, calibrated experiment board, and a detailed experiment manual. The system was designed specifically for student use. We will be happy to give you detailed information on this training unit which explains fully how it can be used by your present staff in chemistry, physics, and biology classes. Just ask for the Classmaster brochure.

nuclear-chicago
CORPORATION
349 HOWARD AVENUE • DES PLAINES, ILLINOIS